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Water Use Efficiency Component. Draft Programmatic EIS/EIR Technical Appendix

CalFed Bay-Delta Program

CALFED
BAY-DELTA
PROGRAM

Water Use Efficiency Component

Programmatic EIS/EIR
Technical Appendix
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WATER USE EFFICIENCY COMPONENT TECHNICAL APPENDIX

-- Public Draft --

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1. Introduction

The CALFED Bay-Delta Program is developing a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta system. Three alternatives to accomplish this mission are being refined and analyzed during Phase II of the Program. These alternatives share a "common program" of measures to ensure that California's water supplies are used efficiently. This common program of measures is the water use efficiency component. The water use efficiency component focuses on improvements in local water use management and efficiency in the urban, agricultural, and diverted environmental (e.g., wetlands, refuges) water use sectors. The component also includes a water transfer element that proposes a policy framework focused on improving processes and facilitating water transfers.

This technical appendix documents the efforts, estimates, and assumptions of CALFED staff, often working closely with stakeholder interests, in the following areas:

- development of an implementable water use efficiency component to include:
  - agricultural water use efficiency;
  - urban water conservation;
  - urban water recycling;
  - effective use of diverted environmental water, and
  - improved water transfer processes
- estimation of potential agricultural and urban water savings as a result of implementing the water use efficiency program policies
- estimation of potential urban water recycling
- development of water transfer policy framework designed to facilitate water transfers within the Bay-Delta system

This technical appendix is organized in chapters that correspond to the items outlined above. A summary of potential water savings resulting from urban and agricultural water use efficiency improvements is presented at the end of this chapter.

Public Policy Foundations

California public policy places a strong emphasis on efficient use of developed water supplies. The California Constitution (Article X, Section 2) prohibits "waste or unreasonable use" of water and excludes from water rights any water that is not reasonably required for beneficial use. The constitutional prohibitions of waste and unreasonable use are repeated in Sections 100 and 101 of the California Water Code. The state's process for appropriation of water rights is also based on furtherance of the constitutional policy of reasonable and beneficial use (Water Code Section 1050). The State Water Resources Control Board can and does place water conservation conditions on water rights permits that it approves.

The California Water Code requires all urban water suppliers to prepare and adopt urban water management plans and requires first consideration be given to demand management measures that offer lower incremental costs than expanded or additional water supplies (Water Code Section 10610 *ET seq.*) The Code previously placed limited planning requirements on agricultural water suppliers, but these provisions have expired as a result of sunset provisions (Water Code Section 10800 *ET seq.*)

State and federal water projects are also affected by efficiency requirements. The Central Valley Project Improvement Act calls for the development of water conservation criteria "with the purpose of promoting the highest level of water use efficiency reasonably achievable by project contractors." Some State Water Project contracts contain conservation requirements, and some water right permits granted to the State Water Project by the State Water Resources Control Board contain specific conservation requirements.

Efforts by the State Water Resources Control Board to place more specific efficiency conditions on water right permits have also led to innovative voluntary efforts. Proposed efficiency requirements in the Board's draft 1988 Water Quality Control Plan for the Bay-Delta prompted efforts which ultimately resulted in the creation of the California Urban Water Conservation Council and implementation of urban Best Management Practices by many urban agencies. The board's draft plan also prompted the negotiation of the *Memorandum of Understanding Regarding Efficient Water Management Practices by Agricultural Water Suppliers in California*.

California public policy also places a strong emphasis on water recycling. California Water Code Section 461 provides that the public policy of the State requires the maximum re-use of wastewater.
California Water Reclamation Law (Cal. Water Code Sections 13550-13556) declares that the people of California have a primary interest in developing water reclamation facilities to meet the State's reliable water needs and augment existing surface and groundwater resources. California Water Code Section 13512 declares the intent of the Legislature and the State to undertake steps to encourage development of water reclamation facilities and beneficial reuse of reclaimed water. The Water Recycling Act of 1991 (Cal. Water Code Section 13577) set recycling goals of 700,000 acre-feet of water annually by year 2000 and 1,000,000 acre-feet annually by 2010.

Further legislative and regulatory provisions reiterate the general tenets of California Water Reclamation Law, specifically focusing on coastal areas. In coastal zone areas, recycling of treated water that would have otherwise been disposed into the ocean, creates a "new" supply of water for that region. This is recognized legislatively in California Water Code Section 13142.5(e), which urges wastewater treatment agencies located in a coastal zone to reclaim and re-use as much of their treated effluent as is practicable. It is also recognized through regulation by the State Water Resources Control Board in its 1984 decision 'in the matter of the Sierra Club, San Diego Chapter', Order #WQ 84-7, where the Board held as follows:

"In this case and all other cases where an applicant...(i.e., for a permit to discharge effluent into receiving waters)..., proposes to discharge effluent once-used wastewater into the ocean, the report of the discharge should include an explanation of why the effluent is not being reclaimed for further beneficial uses." This is consistent with State policy established by the Legislature in Cal. Water Code Section 13142.5(e).

Water Use Efficiency in the Bay-Delta System Today

California's strong public policy emphasis on efficiency, and Californians' strong conservation ethic, are reflected in many outstanding water use efficiency and conservation efforts throughout the state. California irrigation districts and growers have implemented pioneering methods to manage water supplies and improve efficiency. These methods range from canal control and improved flexibility of deliveries to new irrigation system technology to drainage reduction to computerized information on crop water needs. Similarly, urban water suppliers have worked with public interest groups to create the California Urban Water Conservation Council, a nationally recognized forum for the successful advancement of our understanding and implementation of urban water use efficiency measures.

Two steps can be taken to increase water use efficiency. First, CALFED agencies must encourage more water users and water suppliers to implement the proven cost-effective efficiency measures that are being used successfully by their peers throughout the state. Less than half of California's population is served by urban water retailers that are members of the California Urban Water Conservation Council, and less than one-third of the state's agricultural lands are served by irrigation districts that are members of the corresponding Agricultural Water Management Council. Second, CALFED agencies must work with others to identify new opportunities for water use efficiency, including supporting new techniques and technology, and finding ways to implement conservation measures that are cost-effective from a statewide perspective but not from the perspective of the water user or water supplier.

The Basis for a CALFED Water Use Efficiency Common Program

The CALFED Program addresses four categories of Bay-Delta problems: ecosystem quality, water quality, water supply reliability, and system integrity. Efficient use of developed water supplies can contribute to solution of problems in several of these categories. Clearly, water use efficiency can help to achieve the Program's goal for water supply reliability: *Reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system*. In addition, changes in local water management, compatible with intended beneficial uses, can help achieve other objectives of the Program by improving water quality or enhancing ecosystem health.

During April and May of 1996 a series of public meetings and workshops were held to explain the CALFED Program alternatives under consideration at that time and to solicit comments from the public about these alternatives. Citizens from all parts of the state expressed strong support for water use efficiency. There is a strong sentiment that water use efficiency should figure prominently in all the alternatives, and that existing supplies must be used efficiently before we undertake costly efforts to develop additional supplies or improve the ability to convey water across the Delta. The CALFED Program recognizes and agrees with this view and believes that the water use efficiency component has been developed to optimize the implementation of feasible and effective efficiency measures.

Based on the many comments received, the Program created a simplified structure for the Bay-Delta solution alternatives in which several components are very similar among all the alternatives. Water use efficiency, water quality, levee system integrity, and ecosystem restoration are all treated as common programs. For water use efficiency, this means that all three of the alternatives refined and analyzed during Phase II of the Program include very similar approaches to assure that cost-effective efficiency measures are widely implemented. The variable components (Delta conveyance and additional storage) will influence which of these efficiency measures will be cost-effective.

Summary of Potential Water Conservation and Recycling

Improvements in urban and agricultural water use can lead to water savings. Increased use of urban water recycling can lead to additional water supplies to help augment existing supplies. Together, these actions can help reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system.

The following tables summarize the findings detailed in Chapters 4, 5, and 6 of this technical appendix. The values shown represent anticipated water savings that occur beyond No Action levels (beyond the level of conservation expected to occur in the future regardless of a Bay-Delta solution). Both applied water reductions and "real" water savings are shown. Applied water reductions always have the potential to provide water quality and ecosystem benefits. When applied water reductions also become "real" water savings, they generate a water savings that can be reallocated to another beneficial water supply use without harming existing beneficial uses. Not all applied water reductions generate this supply, though. For example, if water used by a city is discharged back into a river where it is used to meet a downstream need, conservation does not mean there is new water in the river. It does mean there may be *cleaner* water, possibly having other *ecosystem* benefits. Conversely, if the city discharges to the ocean, conservation will generate a water supply available to meet other demands, including ecosystem needs.

Variation in Conservation Estimates

The estimates of conservation potential contained in this technical appendix are not the only estimates that will be issued by CALFED agencies during 1998. Also during early 1998, the Department of Water Resources will release a draft update of the California Water Plan, Bulletin 160-98. This draft update will present DWR's estimates of reductions in water demand that may occur from the implementation of various demand management measures, including urban and agricultural water conservation and urban water recycling. The estimates prepared by DWR and CALFED will not be identical, because they are prepared for different planning purposes and they examine different scenarios of the future.

Bulletin 160-98 is a framework for making water resources decisions. Baseline estimates of future conservation savings are prudently conservative so that the future gap between supply and demand is not underestimated. Additional options for potential future conservation savings, which may be more difficult to achieve, are also presented.

CALFED will propose a comprehensive, long-term solution to interrelated resource problems of the Bay-Delta, including water supply reliability. Estimates of conservation savings under the CALFED "no-action" and "with-program" alternatives are being prepared. The no-action estimate will be based on the baseline condition described in Bulletin 160-98, but will describe significantly more water use efficiency potential than the conservative Bulletin 160-98 estimate. The CALFED with-program estimate will be comparable to the options in the bulletin, but will include more water savings from implementation of more efficiency measures. This will reflect the sharp increases in funding and regulatory support that CALFED will propose for water use efficiency programs. The CALFED estimates of water use efficiency are intended to bracket the potential range of savings so that impacts can be identified and assessed.

Table 1.1 below compares projected reductions in applied water and net water savings reflected in draft Bulletin 160-98 baseline, the CALFED No Action conditions, and CALFED with-program. The increment of water savings between the Bulletin 160-98 baseline and the CALFED no-action level represents an increment of efficiency that would likely occur in the absence of a Bay-Delta solution. Implementation of a CALFED solution alternative would be expected to hasten the implementation of measures reflected in the no-action increment plus result in the additional "with-project" increment. Representative values shown in the summary table are all midpoints in value ranges detailed later in this technical appendix. Tables 1.2 through 1.4 provide the reader with ranges determined in the detailed analyses.

Table 1.1 - Estimated Incremental Conservation Occurring by 2020 from Various Sources: Bullet 160-98 Year 2020 Baseline, No Action, and CALFED Program

	Net Water Savings [1] (1,000's of acre-feet annually)		
	Urban	Agriculture	Recycling
Bulletin 160-98 Year 2020 Baseline (occur given existing trends and sets baseline for additional increments)	870	230	470
CALFED No Action (occur as future trends and options in absence of a Bay-Delta solution)	1,480	230	700
CALFED Program (result of CALFED Program actions)	740	160	300
Total	3,090	620	1,470
		Grand Total	5,180[2]

1. "Net water savings" is water available for reallocation to other water supply uses. Reductions in applied water will be even greater.
2. DWR's Bulletin 160-98 projects a water shortage during drought periods, including groundwater overdraft, of nearly 7 million acre-feet. Conservation measures, even in the absence of a Bay-Delta solution, can help significantly reduce this shortage, but will not eliminate it.

Summary of Values Developed in Chapters 4, 5, and 6

Based on the analysis detailed in Chapter 4, estimates of CALFED Program incremental water savings resulting from agricultural water use efficiency improvements are shown in Table 1.2. Urban conservation savings developed in Chapter 5 are presented in Table 1.3. Urban recycling estimates from Chapter 6 are summarized in Table 1.4.

It is very important to recognize that the estimates shown in these tables assume significant implementation of conservation measures over the next 20 year; levels not existing today, but expected by to have been implemented by 2020, regardless of the CALFED Program. Values shown in the tables are the incremental improvements beyond these No-Action levels. Anticipated conservation and efficiency improvements for the No Action alternative are presented in detail in Chapters 4, 5, and 6. The values represent aggressive levels of conservation and recycling. Significant local, regional, state and federal support will be necessary in order to achieve the expected results of the CALFED Program's Water Use Efficiency component.

Table 1.2 - CALFED Incremental Agricultural Water Savings Estimates (1,000 acre-feet)

Geographic Region	Incremental CALFED Applied Water Reduction	Incremental CALFED Real Water Savings [1]
Sacramento River	320-470	0
Delta	60-90	0
San Joaquin River	230-355	30-45
Tulare Lake	400-600	25-35
San Francisco	4-6	0 (minimal agriculture)
Central Coast	6-12	nominal
South Coast	30-50	nominal
Colorado	not applicable [2]	65-105
Total	900-1,600	125-195

1. Incremental real water savings are a subset of incremental applied water reduction. This water savings can be reallocated to other beneficial water supply uses, including the ecosystem, without impact to existing beneficial users.
2. Applied water savings, other than that shown for real water savings and transferred to Delta export water users, is not expected to provide any benefit to the Bay-Delta system and is therefore not included.

Table 1.3 - CALFED Incremental Urban Water Savings Estimates (1,000 acre-feet)

Geographic Region	Incremental CALFED Applied Water Reduction	Incremental CALFED Real Water Savings [1]
Sacramento River	120-135	5-10
San Joaquin River	120-135	5-10
Tulare Lake	105-120	35-45
San Francisco	145-165	135-150
Central Coast	45-55	45-55
South Coast	500-545	430-460
Colorado	not applicable [2]	50-60
Total	1,035-1,150	705-790

1. Incremental real water savings are a subset of incremental applied water reduction. This water savings can be reallocated to other beneficial water supply uses, including the ecosystem, without impact to existing beneficial users.
2. Applied water savings, other than that shown for real water savings and transferred to Delta export water users, does not provide any benefit to the Bay-Delta system and is therefore not included.

Table 1.4 - CALFED Incremental Urban Water Recycling Estimates (1,000 acre-feet)

Geographic Region	Incremental CALFED Total Water Recycling	Incremental CALFED New Water Supply [1]
San Francisco	0 - 110	0 - 90
Central Coast	0 - 45	0 - 35
South Coast	0 - 525	0 - 425
Total	0 - 680	0 - 550

1. Incremental new water supply is a subset of incremental total water recycling. This water savings can be reallocated to other beneficial water supply uses, including the ecosystem, without impact to existing beneficial users.

2. Water Use Efficiency Program Description

Efficiency has several definitions. One is a traditional view of water use efficiency defined in terms of physical efficiency: the ratio of water consumed to water applied. Efficiency can also be defined in economic terms: deriving the greatest economic output from a given input such as a unit of water. For the purpose of developing and implementing a water use efficiency common program, CALFED has defined efficiency somewhat differently: **efficient water use is characterized by the implementation of local water management actions that increase the achievement of CALFED goals and objectives.** This definition includes physical efficiency but is not limited to this narrow definition.

Increases in physical efficiency and increases in the achievement of CALFED objectives through improved water management will be direct results of the Program. Increasing economic efficiency -- which might result in a reallocation of water -- is not a specific objective of the Program and the Program will not take direct action to increase economic efficiency. However, Program actions that facilitate a water transfers market will likely result in improved economic efficiency.

Program Linkages

There are important linkages between water use efficiency and other components of a comprehensive long-term solution to resource problems of the Bay-Delta. Some of these include:

- **Storage and conveyance.** The cost of new storage and conveyance projects will help set the marginal cost of new supplies for many water suppliers. This, in turn, will influence the cost-effectiveness of efficiency measures: if new supplies are expensive, then more efficiency measures will be cost-effective.

- **Delta transfer capacity.** The increase in physical capacity to transfer water across the Delta that may result from new or improved conveyance will be important in determining the maximum extent of water transfers across the Delta.

- **Water Quality.** Increases in irrigation efficiency can reduce the amount of tailwater that drains from a farm field. This may improve in-stream water quality by reducing the return flow of salts, sediments, organic carbon, selenium, or other substances.

- **Ecosystem Quality.** Increased emphasis on efficiency measures will reduce future Bay-Delta system water diversions from what they would be without the implementation of these additional efficiency measures. This will reduce the level of future impacts on aquatic organisms.

- **Financing.** The way that costs of a Bay-Delta solution are apportioned will have significant effects on the cost-effectiveness of efficiency measures. To the extent that the costs of actions such as providing water for ecosystem restoration are reflected in the price that agencies and consumers pay for water, efficiency measures will be made more attractive.

Design of the Program

The physical scope of water use efficiency actions is limited to improvements that can affect Bay-Delta water supplies (surface and subsurface) from points of local diversion for beneficial use to points of local return to the receiving water. This scope focuses on opportunities that are implementable at the local water supplier and end-user level. For example, changing the timing of diversion, reducing demand through conservation and recycling, or improving the quality of a return flow are actions related to beneficial use of local diversions and are implementable at the local and end-user levels. Reservoir operation, upper watershed management, and instream flow standards typically would not fit within the scope of water use efficiency although these issues will be integral to a comprehensive CALFED Program Bay-Delta solution.

CALFED Program's water use efficiency component must also be compatible with the solution principles that the Program has identified to guide development of a Bay-Delta solution. These principles state that a Bay-Delta solution must:

- Reduce conflicts in the system
- Be equitable
- Be affordable
- Be durable
- Be implementable
- Pose no significant redirected impacts

The CALFED Program water use efficiency component differs from other components of the Bay-Delta solution in two fundamental ways. First, the proposed component approaches water use efficiency from a policy perspective. In contrast to all other components of the Program, few technical issues are addressed. Technical questions such as those related to appropriate efficiency measures and implementation levels are largely left to other forums, including the California Urban Water Conservation Council and the Agricultural Water Management Council. Second, implementation of efficiency measures will occur mostly at the local and regional level by local agencies, not by State and federal CALFED agencies.

The role of CALFED agencies will be twofold. First, they will offer support and incentives such as programs to provide planning, technical, and financing assistance. Second, the CALFED agencies will play an important role in providing assurances that cost-effective efficiency measures will be implemented.

The water use efficiency component is divided into five elements to facilitate discussion and development of CALFED Program approaches: urban water use efficiency, agricultural water use efficiency, diverted environmental water use efficiency, water recycling, and water transfers. The first three elements correspond to traditional water use sectors of urban, agriculture, and the environment. Some differences in the water use efficiency approach for each sector may be appropriate because there are differences in water rights, type and method of water use, and potential for reuse. Water recycling will be treated separately for the sake of expediency, because urban water recycling has traditionally been approached separately from urban water conservation, and is often the responsibility of different agencies. Water transfers, which are fundamental to state and federal water policies, are not strictly efficiency measures but they may prompt the implementation of efficiency measures or in some cases provide the funding for efficiency measures on a local basis.

Two work groups of the Bay-Delta Advisory Council were established to address policy issues related to water use efficiency and water transfers. The Water Use Efficiency Work Group provided considerable input to CALFED during development of the common program and served as a public forum for discussion of the program during development. More recently, the Water Transfers Work Group has provided valuable input during development of a policy framework for water transfers.

Implementation Objectives

Implementation objectives were established by the Water Use Efficiency Work Group in order to guide the development of approaches for water use efficiency. These objectives are intended to reflect and protect the various stakeholder interests regarding local water use management and efficiency. The objectives were used during program development to test whether a draft approach was satisfactory.

General Objectives

These objectives apply to the entire Water Use Efficiency Common Program.

- **Ensure a strong water use efficiency component in the Bay-Delta solution** - During the CALFED scoping period and at numerous public meetings, the general public as well as stakeholders said local water use management and efficiency improvements should play an integral role in the Bay-Delta solution.

- **Emphasize incentive based actions over regulatory actions** - The CALFED Program's approach to water use efficiency emphasizes incentives to encourage efficient use. Principal incentives include planning, technical, and financing assistance to local water agencies. Additional incentives include access to potential benefits of the Bay-Delta

Program such as increased water supplies and increased ability to convey transferred water. Regulatory actions provide necessary assurances of efficient use as well as mitigation for third party impacts that may result from incentive-based approaches.

- **Preserve local flexibility** - During the CALFED Bay-Delta Program's scoping period and at numerous public meetings, stakeholders stressed the desire to maintain the flexibility of implementing water use management and efficiency improvements at the local level. The CALFED Program's approach to local water use management and efficiency provides necessary assurances of improved efficiency while maintaining the flexibility to tailor implementation to local conditions.

- **Remove disincentives and barriers to efficient water use** - Water agencies and water users may be discouraged from implementing conservation measures as a result of various disincentives. Examples of disincentives include poorly planned water wholesaler drought water allocation plans, negative impacts to agency operation budgets resulting from reduced water sales, and inability to pass some conservation costs along to customers (as occurs with some investor owned utilities). Removal of disincentives can allow agencies and their customers to implement conservation measures that otherwise could not be justified. However, removal of barriers must support the original purposes of the institutions associated with the measure.

- **Offer greater help in the planning and financing of local water use management and efficiency improvements** - To implement efficient water management practices, some water users need information about proposed measures and may also need the ability to finance implementation of such measures. Greater levels of technical, planning, and financing assistance are essential to improve local water use management and efficiency. This assistance will help agencies use integrated resource planning methods and common approaches to cost-effectiveness determinations, will help agencies recognize the value of conservation, and will allow them to make more informed decisions regarding implementation of such measures.

Urban Objectives

The objectives presented in this subsection relate to urban water use efficiency improvements.

- **Include the strengths and benefits of the CUWCC and the urban MOU** - The California Urban Water Conservation Council (CUWCC) has an established role in the urban water use community relating to the implementation of BMPs. The CUWCC consists of water agencies, environmental and public interest groups, and other interested parties that have signed the *Memorandum of Understanding Regarding Urban Water Conservation in California* (MOU). The strengths of the CUWCC include: ability to foster collaboration among diverse urban agencies and the non-profit community; development of a framework for implementation of urban BMPs; the ability to update BMPs to reflect advances in technology and knowledge in the area of urban conservation; and its ability to allow a signatory agency to exempt itself from a specific BMP given proof of non-cost effectiveness. The urban MOU and the urban water management planning sections of the Water Code represent important accomplishments in urban water management.

- **Provide assurance that a high "floor" level of conservation implementation will occur** - The conservation measures that are most likely to be cost-effective for urban water suppliers are well known. These Best Management Practices are appropriate for almost every agency and define an easily-understood minimum level of conservation effort. Many agencies are implementing BMPs at appropriate levels, but many others are not. The approach to urban water use efficiency must achieve a higher level of BMP implementation, and by more agencies, in order to be credible.

Agricultural Objectives

The objectives presented in this subsection relate solely to agricultural local water use management and efficiency improvements.

- **Build on the progress and achievements of the *Memorandum of Understanding Regarding Efficient Water Management Practices by Agricultural Water Suppliers in California* (AB 3616)** - The AB 3616 process has resulted in an agricultural MOU that emphasizes uniform analysis of efficient water management practices, provides a standardized format for water management plans, and calls for implementation of district level measures that meet criteria contained in the MOU. It, along with recent CVPIA conservation criteria, represent important accomplishments in agricultural water management.

- **Provide adequate assurance that agricultural water supplies will be used at highly efficient levels** - A central tenet of the CALFED process is that all interests will move forward together. As planning for possible improvements in water conveyance and storage moves forward, it will be important for stakeholders and taxpayers to be assured that existing water supplies are being used as efficiently as practical at all levels. The approach taken must provide the information and include the actions to offer this assurance.

- **Improve local water use management to achieve multiple benefits** - Opportunities exist to manage local water use for multiple benefits without adversely affecting any of the users. Examples of these opportunities include development of conjunctive use programs; coordination of releases to correspond with fishery, water quality, and agricultural needs;

and changes in water management that help support wildlife habitat. The program will seek improvements that not only promote water use efficiency but also benefit other resource areas. The program will encourage improved local water use management and efficiency at all levels, from field to basin-wide so that all opportunities for local management and efficiency improvements are identified and the relationships among water uses within a basin are understood. Using and expanding upon the methodologies contained in the Agricultural MOU may help CALFED achieve this objective.

General Assurances

The CALFED Bay-Delta Program solution alternatives include a variety of programs, policies, and actions to provide assurance that appropriate water management planning is carried out by local agencies and that cost-effective efficiency measures are implemented. Certain minimum levels of analysis, implementation, and demonstration of efficient use should be met by every water supplier in California, regardless of the supplier's desire to receive CALFED benefits. This is consistent with California public policy including constitutional provisions prohibiting waste and unreasonable use.

To this end, CALFED and the CALFED agencies will implement three general policies to provide assurance of efficient use. Demonstration that appropriate water management and planning is being carried out and that cost-effective efficiency measures are being implemented will be necessary prerequisites for an agency to be eligible to:

- receive any "new" water made available by a Bay-Delta solution
- participate in a water transfer that requires approval by any CALFED agency or use of facilities operated by any CALFED agency, and
- receive water through the DWR Drought Water Bank (this is already a policy of DWR)

For urban water suppliers, this includes DWR certification of the supplier's urban water management plan and updates, and California Urban Water Conservation Council certification of the supplier's compliance with the terms of the Urban MOU. For agricultural water suppliers, this demonstration includes Agricultural Water Management Council endorsement of the supplier's water management plan and implementation progress reports.

Furthermore, CALFED agencies are considering a policy that would place a higher standard of water management on water suppliers that may want to *receive* water from the CALFED program.

In order to be eligible to receive new water or receive water through transfers or the DWR Drought Water Bank, CALFED agencies are considering the policy that a water supplier must meet criteria for the measurement of water deliveries and water pricing contained in the *Criteria* *for Evaluating Water Management Plans* issued by the U. S. Bureau of Reclamation, Mid-Pacific Region, in September 1996. These criteria state that a water supplier or district will:

1. **Measurement devices** - measure, with a device that is rated to have a maximum error of +/- six percent, the volume of water delivered by the District to each customer; and

2. **Pricing structure** - adopt a water pricing structure for District water users based at least in part on quantity delivered.

New Water

A Bay-Delta solution alternative implemented by the CALFED agencies may produce new or expanded water supplies for all beneficial uses. In order to be eligible to receive any additional water made available, local and regional water suppliers must demonstrate that they are carrying out minimum standards of water management planning as described. They may be asked to meet water measurement and pricing criteria.

The planning and implementation required in order to be eligible for new water supplies are water management activities that all water suppliers should implement regardless of their need for any additional water. Therefore, it is appropriate to define "new or expanded water supplies" in the broadest possible terms. At minimum, new or expanded water supplies will include any supply greater than that which can be delivered under the 1994 Bay-Delta Accord and the Water Quality Control Plan adopted by the State Water Resources Control Board on May 22, 1995.

Water Transfers

A Bay-Delta solution alternative implemented by the CALFED agencies may increase the ability to transfer water, through reduction in physical conveyance constraints in the Delta or other policy changes. If a transfer requires use of DWR or USBR facilities, or requires approval from any CALFED agency, then both the transferring and receiving agency must demonstrate that they are carrying out minimum standards of water management planning as described above. In addition, the receiving agency may be asked to meet water measurement and pricing criteria.

Drought Water Bank

The Department of Water Resources periodically operates a drought water bank to facilitate short-term water transfers to meet critical water needs during severe water-short periods. It is currently the policy of DWR, expressed in the *State Drought Water Bank Program Environmental Impact Report* dated November 1993, that "transfers will only be made to areas where the water supply agency has implemented reasonable and cost effective management and water recycling programs..." In order to receive water from a Drought Water Bank, local and regional water suppliers must demonstrate that they are carrying out minimum standards of water management planning as described above and may be asked to meet water measurement and pricing criteria.

Additional Assurances

Several additional assurances will be important parts of a comprehensive assurances package. These include mechanisms to assure that water retailers are not insulated from responsibility by wholesalers, to guarantee adequate and flexible funding for assistance programs, to encourage and assure implementation of cost-effective, feasible water recycling projects, and to link demonstration of efficient use to implementation of other CALFED actions. Each of these assurance mechanisms is described below. Stakeholder input will be necessary to develop the most appropriate assurances in these areas.

Retail water agencies often receive water supplies from wholesale water agencies, particularly in the urban sector. As a result, application of the above conditions would affect wholesalers but not necessarily retailers. Additional assurance mechanisms will be necessary to make sure that retail water suppliers are not insulated from responsibility for efficient use because of their relationship with a wholesaler that may secure new water supplies or arrange transfers.

Programs to provide technical, planning, and funding assistance will be critical to the success of the proposed water use efficiency elements of a Bay-Delta solution. Stakeholders have identified a need for assurance that a guaranteed source of adequate funding will be made available throughout the CALFED implementation period of 20 to 30 years. In addition, assurance is needed that there will be no redirection of these funds from the described programs, although flexibility of expenditure between activities such as technical assistance and funding assistance would be appropriate. For example, program funding in early years might emphasize technical and planning assistance. As technical and planning expertise was developed at the local agency level, some funds might be shifted to grants or loans for program implementation.

The Urban Water Management Planning Act requires water suppliers to give first consideration to conservation measures when the measures offer lower incremental costs than expanded or additional water supplies (Water Code section 10631(g)). In contrast, the Act's provisions regarding water recycling require only that the supplier's water management plan include information on recycled water and its potential for use as a water source in the supplier's service area (Water Code section 10633(a-f)). It is appropriate to set a higher standard for water suppliers that wish to be eligible to receive CALFED benefits. However, the complexity of water recycling projects and the impediments to their implementation require that careful consideration be given to any additional conditions that may be imposed on agencies that desire CALFED benefits.

A high level of water use efficiency may also be assured through the concept of linked implementation. Widespread demonstration of efficient use by local water suppliers and irrigation districts could be a prerequisite to CALFED implementation of other Program actions for water supply reliability.

Agricultural Water Use Efficiency Approach

Agriculture is an important part of California's economy. This $24-billion-a-year industry produces about 11 percent of the total U.S. agricultural value and 40% of the nation's produce on 9.1 million irrigated acres. The CALFED Bay-Delta Program, by solving interrelated problems of the Bay-Delta system, will help to preserve the viability of agriculture in California. The Program's approach to agricultural water use efficiency will be to encourage cost-effective water use efficiency measures and to achieve other CALFED Program objectives in ways that are compatible with agriculture.

In the case of agricultural water suppliers, the number of efficiency improvements that are cost-effective at the local level is highly constrained by different soil types, growing conditions, market volatility, and other factors. Distribution costs, reflected in the costs of water for districts and users, are far lower for agriculture than for urban agencies because the water is normally not treated or pressurized. Consequently, some efficiency measures will not be cost-effective for districts or users, and some cost-effective measures will not be affordable without financing assistance. However, many water use efficiency actions, such as irrigation scheduling, are implemented by end users without assistance from water suppliers.

In addition, the identification of agricultural efficiency and water use management improvements is complicated. In contrast to many urban agencies, much of the water applied to crops that is excess to plant needs is reused, whether via return flows, deep percolation, or flow to neighboring farms or wetlands. Although excess applications can generate benefits, they can also create negative impacts such as additional fish entrainment or degradation of water quality. Opportunities for improvements are often site-specific, which reduces the practicality of using broadly mandated requirements in an approach. Use of a flexible approach with a focus on incentives is more likely to help identify and implement desired improvements.

In the agricultural sector, the nature and extent of benefits from improvements in local water use management and efficiency might differ from the perspective of a field, farm, irrigation district, or basin. If the perspective is broadened to include environmental and water quality benefits as well as water supply benefits, then additional measures might become available to improve efficiency in the broader sense of meeting CALFED Program objectives. The CALFED Program agricultural water use efficiency approach is designed to identify diverse opportunities for local water use management and efficiency improvements and increase the benefits that can be derived from a unit of water. The program will look to water management techniques that increase the effectiveness of water use management and efficiency at the field, farm, district, and basin level where these are appropriate. In addition, the Program will support measures that cost-effectively increase agricultural production from a unit of water, protect water quality, or increase environmental benefits while meeting agricultural needs.

Agricultural Water Use Efficiency Actions

The agricultural approach recognizes a clear standard for agricultural water management planning and a balanced process for recognition of adequate programs of planning and implementation. The approach is supported by planning and technical assistance, financing assistance, and proposed assurances.

1. Water Management Planning and Implementation

Purpose: Rely on a stakeholder forum to provide a uniform, verifiable, locally directed process for agricultural water management planning and provide a balanced process for review and endorsement of water management plans. Identify and implement opportunities for improved local water use management and efficiency with a focus on water conservation at the water supplier level.

This action is based on the *Memorandum of Understanding Regarding Efficient Water Management Practices by Agricultural Water Suppliers in California* (Agricultural MOU). This MOU is an agreement between signatory agricultural water suppliers and signatory environmental organizations. It was developed by an advisory committee formed pursuant to California State legislation in 1990. The bill number of the legislation was AB 3616, so the MOU and the process that produced it are sometimes referred to by this bill number. The agreement calls for signatory water suppliers to prepare water management plans and submit these plans to a Council composed of representatives of all MOU signatories, including water suppliers and environmental organizations. This Council endorses, or withholds endorsement, of each water management plan. Signatory water suppliers also agree to submit annual implementation progress reports to the Council. The MOU calls for water suppliers to implement certain measures called Efficient Water Management Practices, and to evaluate other Efficient Water Management Practices according to a specified analysis method, implementing those found to be feasible and cost-effective.

The CALFED Program proposes that all agricultural water suppliers should prepare, adopt, and implement water management plans. This is consistent with public policy, state law, and public comments made during scoping for the CALFED Bay-Delta Program. The Agricultural MOU provides a uniform, verifiable, locally directed process for agricultural water management planning.

In addition, the Agricultural MOU provides a process for balanced review and endorsement of plans and implementation progress reports that meet the standards of the MOU. All agricultural water suppliers should submit plans and implementation reports to the Agricultural Water Management Council formed under the terms of the Agricultural MOU for endorsement. Plans may be those prepared by signatory or non-signatory water suppliers which meet the terms of the Agricultural MOU, or conservation plans prepared by Central Valley Project contractors pursuant to the Water Conservation Criteria prepared by the U.S. Bureau of Reclamation.

This part of the water use efficiency common program is supported by proposed assurances. Please see Action 5 below.

2. Technical and Planning Assistance

Purpose: Ensure that lack of technical and planning expertise does not impede implementation of cost-effective measures. Provide easily accessible assistance for planning and implementing local water use management and efficiency improvements.

Technical and planning assistance is vital to the successful achievement of agricultural water use efficiency. Assistance can be directed either at *identification* of opportunities (water management planning, guidebook development, conservation program planning) or at *implementation* of opportunities (short courses, CIMIS irrigation schedules, mobile labs, technical review). Currently, both DWR and USBR provide this kind of assistance directly to their contractors as well as to other water suppliers. Agencies such as the Cooperative Extension and the U.S. Department of Agriculture also provide assistance, including programs directed at water management and efficiency improvements. Under this action, both DWR and USBR will continue to provide technical and planning assistance. Assistance programs will be expanded as necessary to ensure that lack of technical and planning expertise does not impede implementation of cost-effective measures.

Additional assistance may be provided through local programs operated by Resource Conservation Districts, commodity groups, the Agricultural Water Management Council, or water districts themselves.

3. Funding Assistance

Purpose: Ensure that lack of financing ability does not impede implementation of cost-effective measures. Provide easily accessible funding for planning and implementing local water use management and efficiency improvements.

Funding assistance is an integral part of the successful achievement of agricultural water use efficiency. CALFED will facilitate the implementation of local water use management and efficiency improvements by making available flexible funding assistance programs. Funding assistance for water suppliers and end-users, such as existing programs available through DWR, USBR, EPA and others, will continue under this action. Determination of most appropriate programs and levels of funding will be made in coordination with CALFED agencies, consistent with the principle that lack of financing ability should not impede implementation of cost-effective measures. Examples of funding programs include low interest loans, grants, direct financing, rebate programs, and bond pooling.

Funding assistance may be made available directly through State or federal agencies or through regional cooperative groups (e.g. Resource Conservation Districts, Cooperative Extensions, commodity boards), to local water suppliers or individual water users.

4. Management Improvements to Achieve Multiple Benefits

Purpose: Help to meet CALFED objectives, including those related to ecosystem quality and water quality, by encouraging districts to identify opportunities for improvement when preparing water management plans, and creating incentives for implementation.

The planning process described in the Agricultural MOU includes completion of a net benefit analysis which, among other things, will help districts identify environmental benefits and impacts associated with the implementation of Efficient Water Management Practices. Use of the net benefit analysis creates an opportunity for districts to simultaneously identify other local water use management and efficiency improvements which might meet CALFED objectives by improving water quality or ecosystem health. In many instances, it is not cost-effective for local suppliers or water users to implement or even identify opportunities that address these benefits. Yet, from a regional or statewide perspective, implementation of these types of actions can be justified. If additional technical and planning assistance could be provided to districts while they are conducting the net benefit analysis, it would offer an excellent chance to identify additional actions that might improve water quality or ecosystem health.

Incentive payments could be used to encourage implementation of practices that meet CALFED objectives and yield environmental, water quality, or water supply benefits but which are not cost-effective at the local water supplier or water user level. The amount of the incentive payment would need to be sufficient to make the practice cost-effective for the implementing individual or district. For example, incentives could be offered to encourage installation of on-farm measures to improve water quality, or for district level measures to vary the timing of diversions in ways that benefit fish species.

CALFED will take steps to further develop a proposed program to implement management improvements to achieve multiple objectives. These steps may include the following. First, similar programs will be identified and examined. If it appears appropriate, an advisory committee will be established to help define the most effective program. Once a program is better defined, CALFED agencies will assist with implementation, perhaps by developing a guidebook to help districts and interested parties identify opportunities. CALFED agencies may also provide planning or financial assistance to help districts use the guidebook and identify opportunities. Finally, CALFED will provide financial incentives to make identified opportunities cost-effective for local suppliers or users when these opportunities help meet CALFED objectives and priorities. Development of this program will require close coordination with other parts of the CALFED Bay-Delta Program including ecosystem quality, water quality, financing, and assurances.

5. Assurances for Agricultural Water Use Efficiency

Purpose: Provide assurance that agricultural water supplies are used at highly efficient levels.

The CALFED approach to agricultural water use efficiency is based on irrigation districts' cooperation with a voluntary program of planning, analysis, and implementation. While this approach is most desirable from the perspective of water users, a voluntary program does not provide strong assurance that planning, analysis, and implementation of cost-effective measures will be pursued. Therefore, two categories of assurances are proposed: general assurances, and additional assurance mechanisms tailored to the proposed CALFED approach for agricultural water use efficiency.

The general mechanisms provide assurance that appropriate water management planning is carried out by local agencies and that cost-effective efficiency measures are implemented. Demonstration of appropriate planning and implementation will be necessary prerequisites for an agency to be eligible to receive any "new" water made available by a Bay-Delta solution, participate in a water transfer that requires approval by any CALFED agency or use of facilities operated by any CALFED agency, or receive water through the DWR Drought Water Bank (this is already a policy of DWR).

In addition to these general assurances, another mechanism (described below) is proposed to provide this assurance. This proposed agricultural assurance mechanism will be considered together with all other Program assurance needs in developing a final package of assurances.

If an acceptable majority of agricultural water suppliers have not prepared, adopted, received Council endorsement, and begun implementation of their agricultural water management plans by January 1, 1999, then legislative and regulatory mechanisms will be triggered. An acceptable majority includes irrigation districts that serve water to at least two-thirds of the total acreage served by districts in the CALFED solution area, including the Imperial Valley. A deadline of January 1, 1999 was proposed early in 1997 because it accommodates a two year planning cycle as described in the agricultural MOU, and it is short enough so that adequate assurances mechanisms can be put in place before Phase III of the CALFED Bay-Delta Program is initiated. Technical analysis to support the Council's decision of endorsement will be provided by DWR.

If a program of planning, analysis, and implementation does not meet the criteria described above, then CALFED agencies will work to establish legislative and regulatory policies for agricultural water users that are patterned after those that apply to urban water users. This includes an Agricultural Water Management Planning Act patterned closely after the existing Urban Water Management Planning Act and policies of CALFED agencies, as well as additional assurance mechanisms patterned after those that are applied to urban agencies as part of the Bay-Delta Program, including the possibility of State Water Resources Control Board investigation for waste and unreasonable use violations. These assurance mechanisms will need to be enacted before any CALFED Phase III water supply activities can begin.

Urban Water Use Efficiency Approach

The urban areas of California currently use over seven million acre-feet of water each year. The majority of this demand is met by diverting water from the Bay-Delta system. As populations continue to grow, the demand will also grow. The CALFED Bay-Delta Program will help the urban sector meet its future water needs and improve supply reliability through a number of programs, one of which is to facilitate implementation of cost-effective water use efficiency measures.

Generally, over the past three decades, urban per capita water use has stabilized or even decreased in most areas of the State. The implementation of local water conservation programs, along with current housing development trends such as increased multiple-family dwellings and reduced lot sizes, have lowered per capita water use in many areas. However, even with current conservation programs, gross urban applied water demand is projected to grow. Part of this trend is due to increased urban growth in warmer inland areas where landscape irrigation needs are higher.

Developing new water supplies to meet increasing demands, treating this water to meet drinking water standards, and providing the infrastructure to deliver the water to customers is very expensive. In addition, most urban wastewater is typically released to salt sinks, such as the Pacific Ocean or San Francisco Bay, where it cannot be recovered for other uses. The high costs associated with new supplies and the limited opportunities for reuse after discharge tend to make many urban water conservation measures cost-effective and attractive to urban water suppliers.

Many of the more recent locally implemented conservation efforts have resulted from over 150 urban water agencies signing the 1991 *Memorandum of Understanding Regarding Urban Water Conservation in California* (MOU) and beginning to implement BMPs as outlined in the MOU. Efforts to reduce urban demand are projected to continue, creating a potential for very significant water savings. However, the rate and extent of implementation by signatory agencies is currently far below the potential. In addition, many agencies have yet to sign the MOU or develop strong conservation programs. Higher levels of conservation need to be achieved as part of an overall CALFED solution.

Urban Water Conservation Actions

The urban approach recognizes a clear standard for implementation of cost-effective conservation measures and responsibility to carry out local water management planning. The approach establishes a process for recognition of adequate planning efforts and recommends a balanced process for recognition of adequate conservation implementation. The approach is supported by planning and technical assistance, financing assistance, and proposed assurances.

1. Conservation Implementation, Reporting, and Certification

Purpose: Rely on a stakeholder forum to provide a uniform, verifiable, locally-directed process for urban BMP implementation and reporting. Identify and implement opportunities for improved water use efficiency with a focus on water conservation.

The *Memorandum of Understanding Regarding Urban Water Conservation in California* (Urban MOU) provides a uniform, verifiable, locally directed process for implementation of cost-effective urban water conservation programs. All urban water suppliers should implement conservation programs that comply with the terms of the Urban MOU. This is consistent with public policy, state law, and public comments made during scoping for the CALFED Bay-Delta Program.

In contrast to the Agricultural MOU, the urban document does not provide a process for balanced review and endorsement of implementation efforts that meet the implementation levels and schedules of the MOU. CALFED recommends that the California Urban Water Conservation Council adopt a process for endorsement or certification of water supplier compliance with the terms of the Urban MOU. This would help CALFED agencies direct planning, technical, and financing assistance toward local agencies that need this help, and would facilitate the implementation of appropriate assurance mechanisms.

2. Certification of Water Management Planning

Purpose: Help urban suppliers prepare, adopt, and implement useful water management plans and comply with the requirements of the Urban Water Management Planning Act (California Water Code 10610 et. seq.).

California State law recognizes the importance of good water management planning. The State's Urban Water Management Planning Act requires urban water suppliers to prepare and adopt

Urban Water Management Plans and update them every 5 years. Provisions of the Act require agencies to:

- include information on an agency's past, current, and projected water supplies and demands,
- describe opportunities for exchanges or transfers,
- provide an analysis of demand management measures,
- provide a water shortage contingency analysis,
- describe the availability of, and potential for use of, recycled water, and
- assess the reliability of water service in all water year types.

Good-faith compliance with the Act helps agencies to improve water use efficiency, not only through analysis and implementation of BMPs but also through better analysis of water recycling, better long-term planning, and better drought contingency planning. Current efforts by some urban agencies to meet this planning requirement are adequate. However, of the nearly 400 agencies affected by the requirement, many currently fail to adequately address local water management issues and options or fail to produce any plan at all.

The Department of Water Resources currently assists urban water suppliers with the preparation and implementation of Urban Water Management Plans. This assistance will continue. Assistance programs will be expanded as necessary to ensure that lack of planning expertise does not impede preparation and implementation of effective Urban Water Management Plans.

In addition, DWR currently evaluates the Urban Water Management Plans submitted by the agencies. This evaluation process will be formalized to include a certification process for plans that comply with the terms of the Act. This will help DWR and other CALFED agencies direct planning, technical, and financing assistance toward local agencies that need this help, and will facilitate the implementation of appropriate assurance mechanisms.

3. Technical and Planning Assistance

Purpose: Ensure that lack of technical and planning expertise does not impede implementation of cost-effective measures by providing easily accessible assistance for planning and implementing local water management programs.

Technical and planning assistance is vital to the successful implementation of cost-effective conservation programs. Assistance can be directed either at *identification* of opportunities (water management planning, guidebook development, conservation program planning) or at *implementation* of opportunities (water audit training, mobile labs, technical review). Currently, both DWR and USBR provide this kind of assistance directly to their contractors as well as to other water suppliers. Under this action, both DWR and USBR will continue to provide technical and planning assistance. Assistance programs will be expanded as necessary to ensure that lack of technical and planning expertise does not impede implementation of cost-effective measures.

Additional assistance may be provided through local programs operated by Resource Conservation Districts, the California Urban Water Conservation Council, or water suppliers themselves.

4. Funding Assistance

Purpose: Ensure that lack of financing ability does not impede implementation of cost-effective measures. Provide easily accessible funding for planning and implementing water management programs.

Funding assistance is an integral part of the successful implementation of water management programs. CALFED will facilitate the implementation of local water management improvements by making available flexible funding assistance programs. Funding assistance for water suppliers and end-users, such as existing cost-sharing programs available through DWR, USBR, EPA and others, will continue under this action. Determination of most appropriate programs and levels of funding will be made in coordination with CALFED agencies, consistent with the principle that lack of financing ability should not impede implementation of cost-effective measures. Examples of funding programs include low interest loans, grants, direct financing, rebate programs, and bond pooling.

5. Assurances for Urban Water Management and Conservation

Purpose: Provide assurance that urban water suppliers will carry out good water management planning and implement cost-effective conservation programs.

Two categories of assurances are proposed: general assurances, and additional assurance mechanisms tailored to the proposed CALFED approach for urban water conservation.

The general mechanisms provide assurance that appropriate water management planning is carried out by local agencies and that cost-effective efficiency measures are implemented. Demonstration of appropriate planning and implementation will be necessary prerequisites for an agency to be eligible to receive any "new" water made available by a Bay-Delta solution, participate in a water transfer that requires approval by any CALFED agency or use of facilities operated by any CALFED agency, or receive water through the DWR Drought Water Bank (this is already a policy of DWR).

The Urban MOU provides a recognized standard for minimum implementation of cost-effective urban water conservation programs. CALFED recommends that the California Urban Water

Conservation Council adopt a process for endorsement or certification of water supplier compliance with the terms of the Urban MOU. A process of certification coupled with sanctions for failure to comply with the terms of the Urban MOU will help assure that appropriate cost-effective measures are being implemented. This proposed assurance mechanism will be considered together with all other Program assurance needs in developing a final package of assurances.

The assurance mechanism described below identifies a central role for the Council. CALFED recognizes that such an approach will require the explicit approval of the full Council in order to succeed. Furthermore, CALFED understands that California Urban Water Agencies and the Environmental Water Caucus are currently working on development of a proposed urban water use efficiency approach that may include recommendations for certification and assurances. Such an approach, carrying the broad support that comes with development by stakeholders, may eventually influence the content of the CALFED adopted approach

The proposed assurance mechanism includes a graduated set of non-compliance sanctions directed at urban water suppliers including retail and wholesale agencies. Proper authority to implement sanctions will likely require legislation. Sanctions will include non-compliance fees combined with the possibility of a State Water Resources Control Board (SWRCB) investigation for waste and unreasonable use violations.

CALFED recommends that the Urban Council periodically review the status of BMP implementation for each urban water supplier, including MOU signatories and others, and bestow or withhold certification that a supplier is complying with the terms of the Urban MOU. Technical analysis to support the Council's decision of certification could be provided by DWR. Each time certification is withheld, the agency could be subject to the next level of sanctions. Initially, if an agency is not certified , the agency could be given a limited time extension for revising and completing a certifiable report. However, if the agency continues to be denied certification because of lack of implementation efforts, a first tier non-compliance fee could be levied. Upon a second failure to be certified, which could occur as early as the next reporting period, a second tier non-compliance fee could be levied. If an agency fails to be certified a third time, even if not during consecutive reporting periods, the Council could recommend that the SWRCB investigate the agency for possible waste and unreasonable use violations.

The SWRCB currently has the authority to investigate such violations. Because of a lack of the necessary resources, the SWRCB does not typically initiate investigations but rather responds to complaints of waste and unreasonable use that can be substantiated by the complainant. To alleviate this problem, non-compliance fees could be directly deposited in a fund to be used by SWRCB for employing staff to perform investigations requested by the Council. Alternatively, the Council could hold funds in an account and make an allocation to the SWRCB each time a violation is referred. This will help ensure that the SWRCB has ample resources to exercise its existing authorities.

Approach to Effective Use of Diverted Environmental Water

In addition to the broad categories of urban and agricultural water needs, there are important environmental needs for adequate water supplies. These needs include appropriate instream flows, where water is the environment that supports aquatic species and processes, as well as needs for water diverted from the system to support a variety of public and private wetland areas such as national wildlife refuges and state wildlife areas. The CALFED Bay-Delta Program is examining both instream environmental water use and water diverted for environmental purposes. The instream environment is being addressed within the Program's ecosystem restoration program, while policies related to efficient use of environmental diversions are being examined in the context of the water use efficiency program.

There are many parallels between urban and agricultural water use, discussed above, and environmental water use on wetlands and refuges. First, the five general objectives for water use efficiency are applicable to environmental diversions. Second, there is a need to identify management practices that should be considered and analyzed by refuge managers. Finally, there is a need for assurance that appropriate planning and implementation will take place so that environmental diversions are used efficiently, just as there is need for assurance of efficient use in the urban and agricultural sectors.

Three of the CALFED agencies (the California Department of Fish and Game, the U.S. Bureau of Reclamation, and the U.S. Fish and Wildlife Service) are working with the Grassland Resource Conservation District to develop an Interagency Coordinated Program for optimum water use planning for wetlands of the Central Valley. This program may include "Best Management Practices" for efficient water use or development a water use management planning process for refuge and wetland areas of the Valley. The program will include stakeholder and public involvement, and expects to have draft work products developed during 1998.

The Interagency Coordinated Program is being developed under the auspices of the Central Valley Project Improvement Act. The Interagency Coordinated Program will work closely with, and coordinate with, CALFED to assure consistency of policy and solution principles, meet the general implementation objectives for water use efficiency, and propose mechanisms that assure the efficient use of water on refuges, wildlife areas, and managed wetlands.

Water management on wetlands is different in many ways from agricultural water management. Thorough analyses of both may lead to the identification of opportunities that will help meet various Bay-Delta Program objectives without impairment of the primary use of diverted water. For example, changes in the timing of drainage releases from either wetland areas or farms may improve instream flows at critical times or improve water quality. The Interagency Coordinated

Program and CALFED Program development will be closely coordinated to identify actions that are similar between wetlands and agriculture, such as incentives for voluntary implementation of actions that meet the objectives and priorities of CALFED and CVPIA. .

Water Recycling Approach

Water reclamation and reuse, referred to as "water recycling," is a safe, reliable, and locally controlled water supply. Tertiary treated, disinfected recycled water is permitted for all non-potable uses in California through Title 22 of the State Health and Safety Code. Moreover, under specific conditions, advanced treated reclaimed water can be used to augment ground or surface drinking water sources. Advanced treated reclaimed water is presently under consideration for regulation in the groundwater case, and for demonstration projects in the surface water augmentation case.

Recycled water supplies are projected to grow. In 1996 the California Department of Water Resources conducted a *Survey of Water Recycling Potential* to help identify and quantify recycling plans. The survey identified actual recycling of nearly 350,000 acre-feet annually in 1996, and projected recycling of 1.48 million acre-feet annually by 2020. It should be noted that these projected reuse totals represent the plans of local water and sanitary agencies. They do not necessarily represent the total recyclable waste stream, or *actual potential reuse*. The California Department of Water Resources is presently calculating the actual potential total recycled water supply in conjunction with its Bulletin 160-98, *California Water Plan Update*. The WateReuse Association of California, in its *Survey of Water Recycling Potential*, 1993, estimates the total wastewater flow to the ocean and other saline water bodies to be 3 million acre-feet. This waste stream, or some economic portion of it, better approximates the potential for water recycling. This number, as stated above, will be updated by DWR for its *California Water Plan Update*.

Local agencies' plans and their actual project development do not match. For example, the WateReuse Association's 1993 Survey reported local agency plans to reuse over 650,000 acre-feet of reclaimed water by 1995. This level of reuse did not materialize. The DWR 1996 Survey reports total 1996 reuse of nearly 350,000 acre-feet. This total is slightly over half of the total quantity of expected 1995 reuse reported in the 1993 Survey.

The most obvious reason for the shortfall between 1993 projections for 1995 and the actual 1996 usage, stems from the fact that when the 1993 Survey was being prepared when the memory of recent drought was vivid. By 1996, wet years may have diminished the support for projects to recycle water. When asked about the factors that affect water recycling decisions, respondents reported that "memory of the last drought" and "concern over long-term supply" were both weighted more heavily than other factors as "most likely" to affect recycling decisions. "Budget problems" and "recession" were identified as the least likely to affect recycling decisions.

The most obvious characteristic of recycled water project development is that it is a local decision. In some regions of California, larger water wholesaling agencies have local project programs that provide a financial contribution for each new acre-foot of water that their member agencies develop. These local project programs have had excellent success encouraging water recycling programs.

Water Recycling Project Development Actions

1. Water Recycling Planning and Implementation

Purpose: Provide a uniform, verifiable, locally directed process for recycled water market identification and integrated water and wastewater project planning for water recycling

Presently, all urban water agencies that are required to prepare Urban Water Management Plans (California Water Code Section 10610 ET. Seq.) must also prepare a water recycling feasibility plan within the UWMP process (Water Code Section 10631). The 1995 UWMP's were the first that included this required feasibility analysis.

Action #2 under Urban Water Conservation Actions is the certification of water management planning. Action #2 includes certification by DWR of agencies' preparation of water recycling feasibility plans that meet the requirements of the Urban Water Management Planning Act.

(Water recycling is not one of the BMPS listed in the 1991 Urban MOU. Water recycling planning and implementation would be assisted by creating a new BMP encouraging water recycling market evaluation and project feasibility evaluations. CALFED recommends that the Urban Water Conservation Council consider such a BMP.)

2. Water Recycling Technical and Planning Assistance

Purpose: Ensure that lack of technical and planning expertise does not impede implementation of cost-effective water recycling projects by providing easily accessible assistance for planning and implementing local water recycling market evaluations, integrated water and wastewater project planning, and financial evaluations leading to accessing special water recycling funding opportunities.

Technical and planning assistance is critical to the successful achievement of feasible water recycling plans, and ultimately, projects. Assistance will be directed in three key areas.

The first important area is identification of *local scale* water recycling projects. The California Urban Water Agencies and the WateReuse Association are developing a guidebook describing methods for the evaluation of water recycling projects. CALFED agencies will provide technical and planning assistance to facilitate use of this guidebook. The guidebook and technical assistance will help local agencies carry out the engineering, economic, financial, and environmental impact evaluations that can lead to successful project implementation on the local level. It will also highlight the information needed to obtain any necessary permits or actions from regulatory agencies.

The second important area is local agency encouragement leading to participation in regional-scale project planning by evaluating and informing them about the benefits to them of participation. DWR provides some local-scale technical and planning assistance through their Water Recycling Specialist. Under this action, CALFED agencies will continue to provide technical and planning assistance and continue to participate on regional water recycling feasibility studies. Assistance programs will be expanded as necessary to ensure that lack of technical and planning expertise does not impede implementation of cost-effective measures. Additional assistance may be provided by regional water agencies and sanitation districts whose member units may require this type of assistance.

The third is the identification and successful introduction to local agencies of *regional-scale* opportunities for additional water recycling such as the Southern California Comprehensive Water Reclamation and Reuse Study and the Central California Regional Water Reclamation and Reuse Study (see activity 4 below).

3. Funding Assistance

Purpose: Ensure that lack of financing ability does not impeded implementation of cost-effective measures. Provide easily accessible funding for planning and implementing local water recycling projects.

Funding assistance is an integral part of the successful optimization of water recycling potential. CALFED will facilitate the implementation of local water recycling projects by making available flexible funding assistance programs or augmenting funding in existing programs at the State level. Both SWRCB and DWR have financing programs for the purpose of funding recycled water treatment plant and distribution facilities. Funding programs like those at DWR, SWRCB, and USBR, through Title 16, P.L. 102-575, will continue under this action. Establishment of appropriate guidelines for awarding the funding should be developed in cooperation with the water recycling industry and other interested parties.

4. Identify and encourage regional water recycling opportunities that maximize reuse at minimum cost

Purpose: Provide opportunities for local water and sanitary agencies to join together to plan regional projects to their mutual benefit.

Regional water recycling projects have a potential advantage over single-community, local projects to optimize water reuse in those regions. Optimization of water recycling potential at minimal cost can best be realized by evaluating the transfer of recycled water from areas of excess supply to areas of excess demand, identify regional seasonal storage opportunities, and regional brine line feasibility. Regional partnerships between local water and wastewater agencies can enhance the success of regional projects.

Presently both USBR and DWR participate with water and wastewater agencies in some regional-scale feasibility studies of water recycling potential along with local and regional water and sanitation agencies that cost-share with DWR and USBR on these studies. CALFED will encourage participation in additional regional studies with the intent of optimizing recycled water use at minimum cost. Financial assistance (see activity #3), should be used to encourage local agency participation in the regional planning activities.

5. Assurances for Water Recycling

Purpose: Provide assurance that urban water suppliers will carry out good water recycling analysis and planning and implement cost-effective recycling programs.

Water Transfers

The CALFED Program recognizes that water transfers are an important part of the California water management landscape and are valuable in the effort to improve water supply reliability, water use efficiency, water quality and the aquatic ecosystem. Transfers can provide an effective means of moving water between users on a voluntary and compensated basis, as well as a means of providing incentives for water users to implement management practices which will improve water use efficiency. Transfers can also provide water for environmental purposes in addition to the minimum instream flow requirements.

The CALFED water transfer element will propose a policy framework for water transfer rules, baseline data collection, public disclosure, and analysis and monitoring of water transfers. The element, in its final form, may also identify areas where additional regulation or statutory changes are desirable. Section 7 of this technical appendix fully describes the water transfer element.

3. Determination of Geographic Zones

To facilitate estimation of water use efficiency improvements, zones have been created that group together geographic areas with similar characteristics. Specific zones have been developed for each of the three water use sectors: urban, agricultural, and diverted environmental.

The CALFED Bay-Delta Program's Programmatic EIR/EIS report is also being separated into geographic zones, but in this case, to facilitate the presentation of information. Because the PEIS/EIR includes many more issues than just water use efficiency, the water use efficiency zones were developed to fall within the PEIS/EIR zones.

The pie-chart shown in Figure 3.1 provides an indication of the relative magnitude of each of the three water use sectors. The following sections of this report attempt to provide estimates of conservation potential for each.

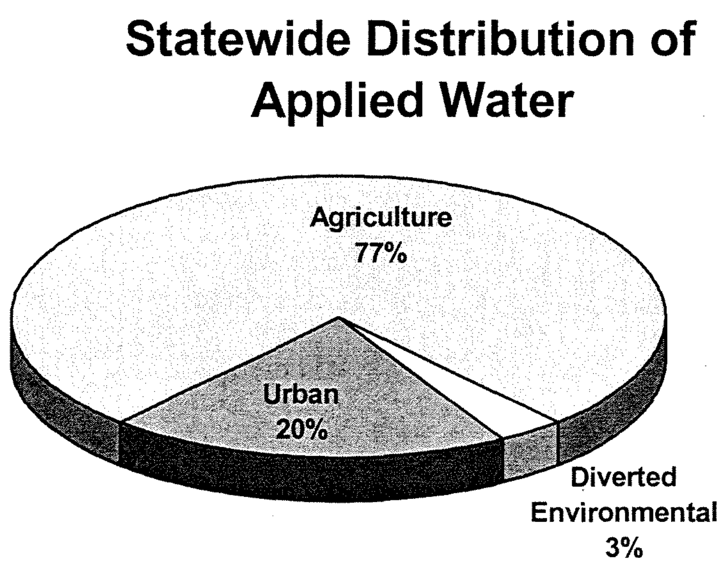

Figure 3.1 - Statewide Distribution of Applied Water Use. Agriculture applies the greatest quantity of water because of the tremendous number of acres producing agricultural crops throughout the state of California. Diverted environmental use is a very small percentage of applied water, but overall environmental water use (including instream flows) is equivalent to agriculture.

Many efforts have been undertaken in the past to estimate the potential of water use efficiency improvements. Each of these have developed or presented information using a defined boundary. One of the more common boundaries is the Department of Water Resources' Planning Subareas

(PSA). There are 44 PSA's that cover the entire state of California. Information at the PSA level is also readily available for use in this analysis and has been used for other investigative purposes such as for the Bureau of Reclamation's *Least-cost CVP Yield Increase Plan* (October 1995). For water use efficiency estimation purposes, grouping the PSA's into common zones was believed to provide the appropriate level of detail for a programmatic level analysis. PSA's have been grouped into the zones described below for each of the three water use categories.

Agricultural Zones

The agricultural approach to water use efficiency is focused on identifying and implementing improvements in local water use management and efficiency. This will include conservation of losses and changes in local management to gain multiple benefits from existing water supplies. Major differences in the potential resulting from efficiency improvements exists among regions of the state. For instance, conservation of "lost" water typically can only occur where water flows to salt sinks or unusable bodies of groundwater, which can occur in areas that export water from the Delta. Conservation potential would then further depend on soil, crop, climate, as well as other site-specific characteristics. On the other hand, changes in local water use management to possibly achieve a secondary ecosystem benefit are more apt to occur in areas that directly divert water from natural streams and rivers. Because of these differences, it is appropriate to develop estimates that are locally specific. However, though differences exist, there is limited information to allow a full understanding of local variations. Therefore, the following grouping of PSA's was established to group areas that had regional similarities. PSA's are listed beneath each zone designation. Figure 3.2 represents a graphical view of the agricultural zones.

Zone AG1
Sacramento River Region
- Northwest Valley
- Northeast Valley
- Central Basin West
- Central Basin East

Zone AG2
Delta Region
- Delta Service Area (Sacramento HR)
- Delta Service Area (San Joaquin HR)

Zone AG3
Westside San Joaquin River Region
- Valley West Side

Zone AG4
Eastside San Joaquin River Region
- Eastern Valley Floor
- Valley East Side

Zone AG5
Tulare Lake Region
- San Luis West Side
- Kings-Kaweah-Tule Rivers
- Kern Valley Floor

Zone AG6
San Francisco Bay Region
- North Bay
- South Bay

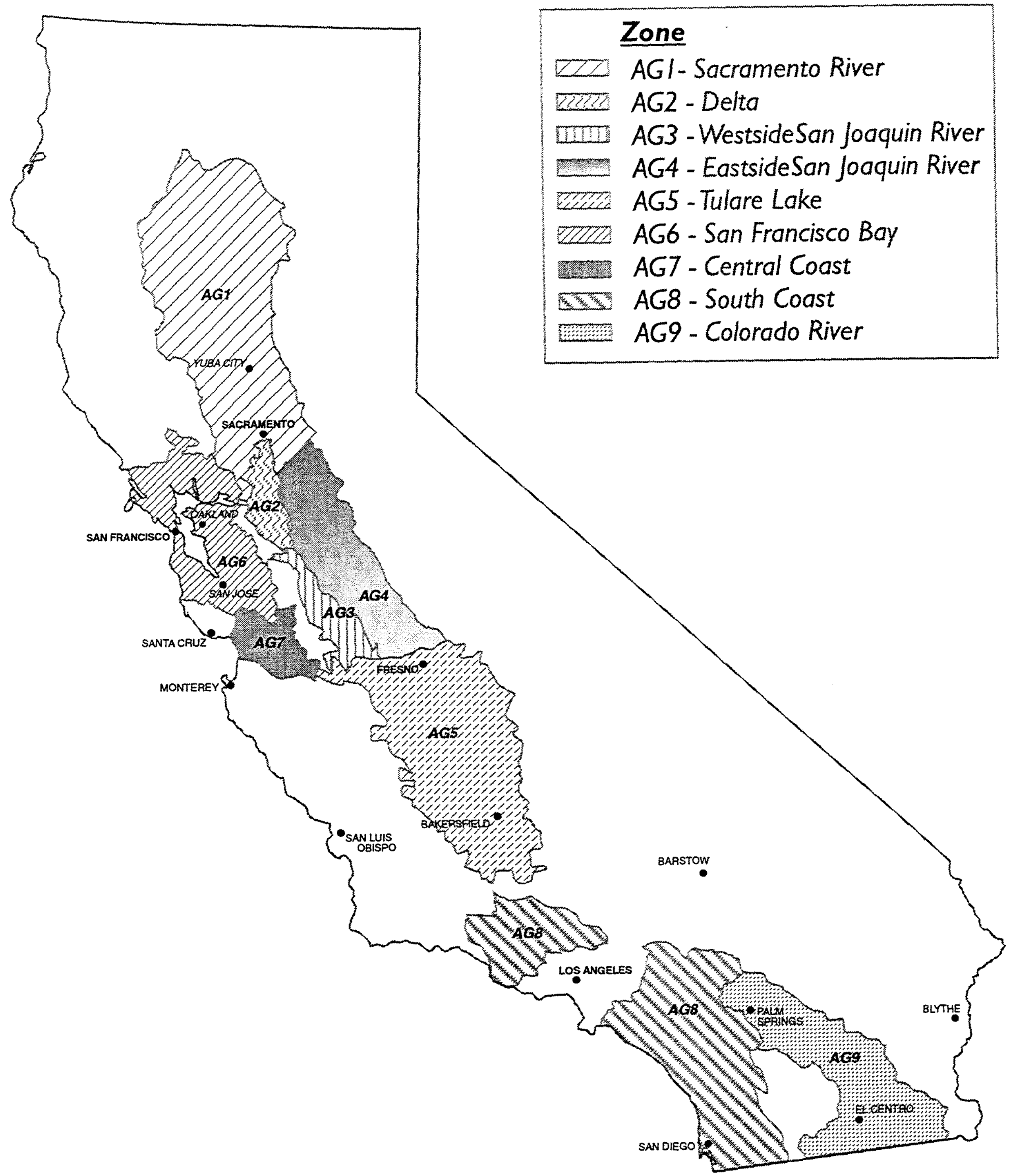

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Figure 3.2
Agricultural Regions

Zone AG7
Central Coast Region
- Northern (portion connected to San Luis Reservoir)

Zone AG8
South Coast Region
- Santa Clara
- Santa Ana
- San Diego

Zone AG9
Colorado River Region
- Coachella
- Imperial Valley

By inspection, not all PSA's are included in the agricultural zones presented. PSA's not included were felt to have limited agricultural activity or were determined to be outside of the CALFED solution area. For instance, the Northern PSA under the Central Coast region has been included because of State Water Project agricultural deliveries to the southern Santa Clara Valley. The Southern PSA under the same region is not included because of agricultural water supplies do not originate from the Delta. Areas of the Imperial Valley have been included because potential conservation savings could be used to offset existing or future Delta demands of the South Coast region.

PSA's included under each zone were assumed to represented the majority of the agricultural production areas. For programmatic impact analysis purposes, this is believed to provide the necessary level of detail for determination of potential impacts.

Urban Zones

The urban approach to water use efficiency is focused on identifying and implementing conservation and water reuse measures. Conservation measures implemented in some regions will reduce water demands, saving water otherwise lost to saline sinks (e.g., the Pacific Ocean). Other regions may not truly save water but can reduce the cost of treatment and distribution and have secondary benefits to the environment. Because of the variation in conservation and reuse goals, urban areas have been separated into the same regional zones used for agricultural. Although the urban geographic zones may not differ from that used for agriculture, the PSA's within the zones will. For instance, conservation or reuse potential in the Sacramento River Region is mainly limited to the Central Basin East PSA. The South Coast Region includes a PSA aptly named "Metropolitan LA" which was excluded from the agricultural zone. The following grouping of PSA's was established to group areas that had regional similarities. PSA's are listed beneath each zone designation. Figure 3.3 represents a graphical view of the urban zones.

Zone UR1
Sacramento River Region
- Central Basin East

Zone UR2
Eastside San Joaquin River Region
- Eastern Valley Floor
- Valley East Side

Zone UR3
Tulare Lake Region
- Kings-Kaweah-Tule Rivers
- Kern Valley Floor

Zone UR4
San Francisco Bay Region
- North Bay
- South Bay

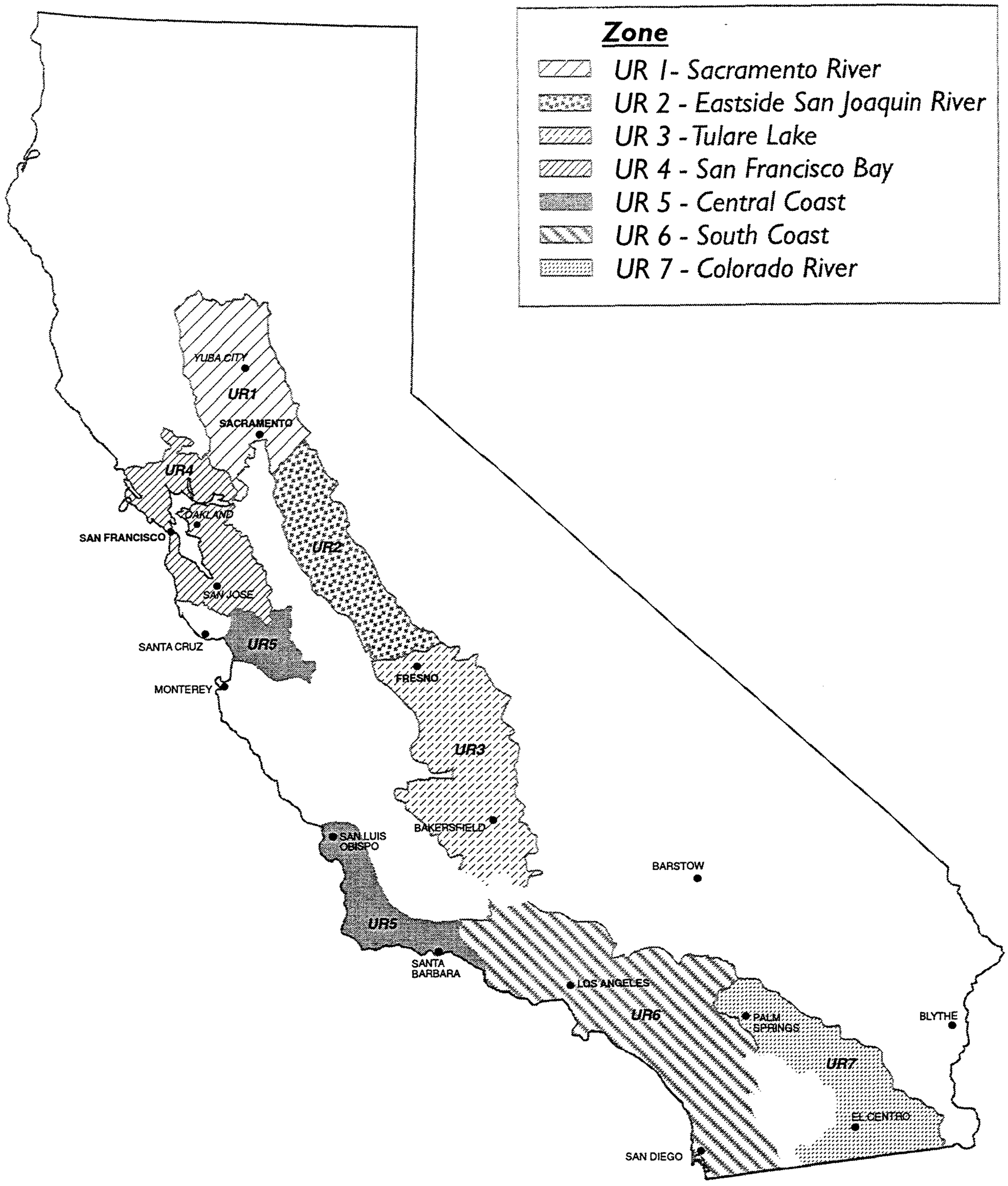
Zone UR5
Central Coast Region
- Northern (portion connected to San Luis Reservoir)
- Southern (portion connected to Central Coast project)

Zone UR6
South Coast Region
- Santa Clara
- Metropolitan LA
- Santa Ana
- San Diego

Zone UR7
Colorado River Region
- Coachella
- Imperial Valley

Similar to the agricultural zones, not all PSA's are represented in the above designations. For instance, the Sacramento River Region is limited to the PSA containing the Sacramento metropolitan area. Other urban areas in the Sacramento Valley have much smaller population centers. Areas of the Imperial Valley have been included because potential conservation savings could be used to offset existing or future Delta demands of the South Coast region.

PSA's included under each zone were assumed to represent the majority of the populated urban areas that derive their water supplies from the Delta or its tributaries. For programmatic impact analysis purposes, this is believed to provide the necessary level of detail for determination of potential impacts.



139888.A2.ZZ Figure Y 3.3/JAN 98 1-9-98sbm

Figure 3.3
Urban Regions

4. Agricultural Water Use Management and Efficiency Improvements

This section presents the basis and background for estimating potential water savings and identifies related impacts that may occur as result of the CALFED No Action alternative and as a result of the CALFED Water Use Efficiency Program, or CALFED alternative. The proposed CALFED approach to agricultural water use efficiency is focused on local identification and implementation of new measures, as well as expansion of existing measures, to improve local agricultural water use management and efficiency. Local involvement is anticipated to further advance water management in California.

This section is intended to be used solely for Phase II impact analysis and is not intended to provide planning recommendations. The following information is included:

- Potential reductions in losses resulting from efficiency improvements, either as real water savings, or benefits to water supply reliability, water quality or the ecosystem,
- the cost associated with implementing agricultural efficiency improvements, and
- the potential impacts from efficiency improvements to various resource categories.

Summary of Findings

Improvements in on-farm and district level efficiency can result in the reduction of losses typically associated with the application of irrigation water to fields. Though the majority of loss reduction does not generate real water savings and cannot be reallocated to other beneficial uses, it can provide significant benefits to water quality and the ecosystem. Estimates are separated into two categories:

- estimated real water savings resulting from a reduction in irrecoverable losses, and
- estimated applied water reduction resulting from reduction in recoverable losses. (This category of loss reduction does not result in water that can be reallocated to other beneficial water supply uses.)

Based on the detailed assumptions and data described later, the estimates of cumulative loss reduction (for both real water savings as well as applied water reductions) are shown in Figures 4.1 and 4.2.

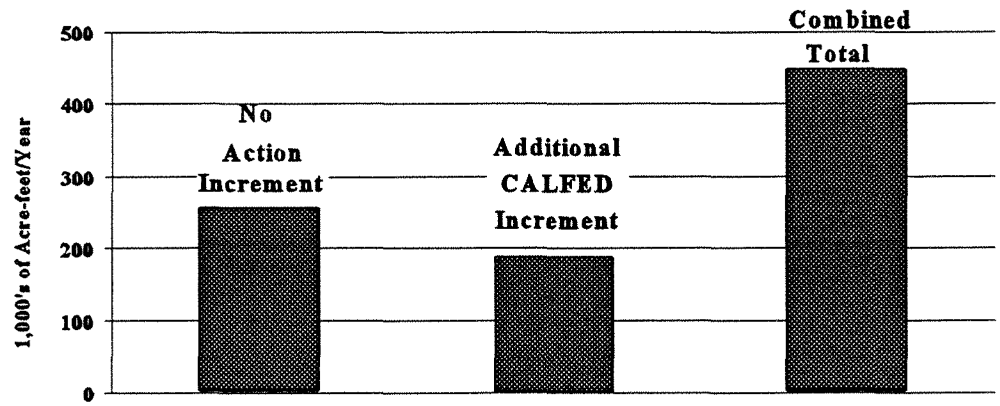


Figure 4.1 - Estimated Statewide Range of Real Water Savings
The incremental portion generated by CALFED is less than half of the total projected savings. This water can be reallocated to other beneficial uses.

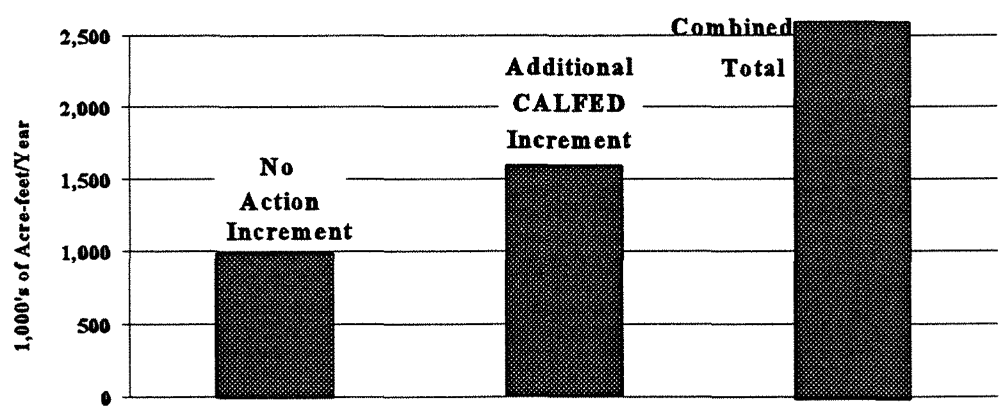


Figure 4.2 - Estimated Statewide Range of Applied Water Reduction
These reductions can provide water quality and ecosystem benefits. The reductions do not constitute a reallocable water supply.

Although the total potential loss reduction estimates shown here are sizable, it must be recognized that they assume all agricultural water users within the CALFED solution area will achieve an 85 percent level of efficiency and irrigation system distribution uniformity will increase to between 80 and 90 percent. To achieve this will require increased levels of support and commitment from federal, state, and local agencies.

Costs associated with implementing improvements to achieve these loss reductions will vary case-by-case. Both on-farm and district spending are necessary in order to obtain the anticipated levels of improvement. Generally, the on-farm cost to reduce applied water ranges from $35 to $95 per acre-foot annually. District expenses can add an additional $5 to $12 per irrigated acre per year to the cost of improved efficiency. In contrast, the range of cost to generate real water savings from reductions in applied water is much greater because in many cases only a small fraction of applied water reduction will yield real water savings (see Figure 4.3). Where real water savings do occur (as a result of reduced irrecoverable losses), the cost for real water savings is estimated to range from $80 up to $850 per acre-foot per year. A detailed discussion of cost is provided toward the end of this section.

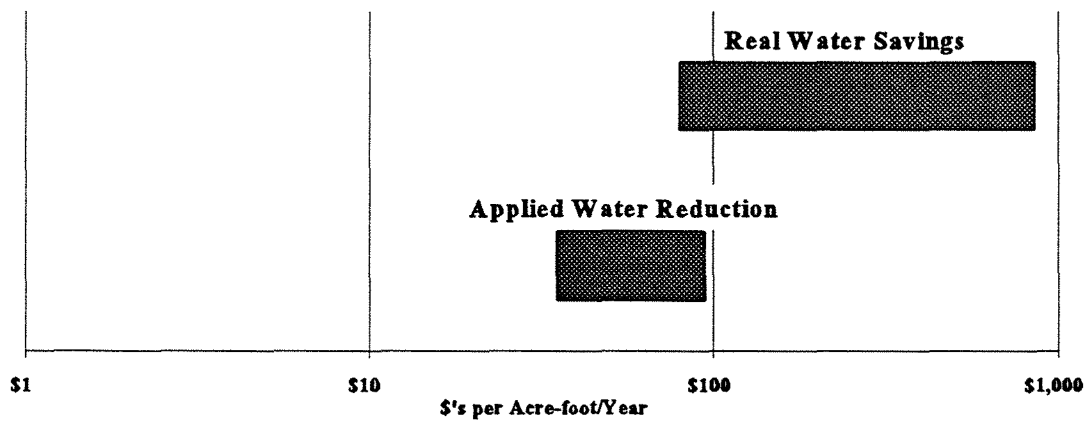


Figure 4.3 - Estimated Range of Cost to Improve On-farm Irrigation Efficiency
Generating real water savings can cost significantly more than reducing applied water

Section Overview

The remainder of this section provides a more detailed discussion on the basis used to estimate the potential reduction of losses. The section is subdivided into the following topics:

- General state-wide assumptions
- Specific state-wide assumptions - including the basis for projecting on-farm and district level efficiency improvements for the CALFED No Action alternative as well as those anticipated for the CALFED solution alternative.
- Irrecoverable versus recoverable losses - including differentiation of the two types of losses and the benefits that can be derived from each.
- Regional reduction estimates - including descriptions and assumptions for each agricultural zone and the resulting projection of loss reduction.
- Estimated cost of efficiency improvements - including cost information for each agricultural zone associated with implementing efficiency improvements.
- Anticipated impacts, beneficial and adverse, resulting from efficiency improvements

General State-wide Assumptions

Information presented in this section is for the sole purpose of identifying potential impacts, both beneficial and adverse, as part of the CALFED Bay-Delta Program Programmatic EIR/EIS. Neither the information nor the analysis is intended to be used for planning recommendations. Impacts associated with anticipated actions will be described in more general terms than may be presented in a site specific EIR. Therefore, information developed here, as a first step in impact analysis, is based on broad assumptions. The general state-wide assumptions listed below guided the development of necessary information used during the analysis of impacts. Specific assumptions are described for each agricultural zone later in this section.

- It is assumed that irrigated agricultural acreage will not increase in the future. Therefore, increased water use efficiency in the agricultural sector is not assumed to result in increased irrigated acreage. State-wide, agricultural acreage is expected to decline as a result of Central Valley urbanization, loss of soil productivity, ecosystem restoration activities, land retirement, water transfers, as well as other factors (DWR, Bulletin 160-93). Estimates of loss reduction have been adjusted accordingly to account for this anticipated reduction by using acreage forecast made by DWR for 2020.

- Conservation of water that results in additional water supply is limited to the reduction in irrecoverable losses. These include losses to evaporation, evapotranspiration of non-agricultural plants, saline sinks, and poor-quality perched groundwater. Further discussion of this is included later. There are other changes in water and farm management that would reduce consumptive water use by agriculture, but these measures are not considered efficiency improvements but changes of use. These measures include changes in crop mix, fallowing, and permanent land retirement.

- Conservation of water in areas where water returns to the hydrologic system in a usable form can potentially be credited with ecosystem or water quality benefits but typically not water supply benefits. Benefactors of existing methods of water application that may be adversely impacted when changes are made need to be taken into consideration when implementing efficiency measures. These include secondary agricultural users, multiple reuse, seasonal wetlands, and riparian habitat in drains. For example, a measure to reduce diversions and associated fish entrainment impacts by implementing conservation measures may adversely impact habitat in a drainage course that currently survives off of the "excess" applied water.

- Water previously beneficially used that is conserved (either by the supplier or the water user) is assumed to remain in the control of the supplier or water user for their discretionary use or reallocation. This could include applying the "saved" water to additional under-irrigated lands, offsetting groundwater overdraft, or transferring to another benefactor, including the environment.

- It is not the intention of this effort to reanalyze estimates of water use efficiency improvements that have recently been developed by others. This effort has directly included or has been influenced by information developed or presented by the following:

  -Department of Water Resources (DWR). 1994a. "California Water Plan Update." Final Bulletin 160-93.
  -Department of Water Resources (DWR) - internal staff work developed as background and draft input data for Bulletin 160-98.
  -U.S. Department of Interior (DOI) - Bureau of Reclamation, Mid-Pacific Region and Fish and Wildlife Service. September 1995. "Demand Management - Technical Appendix #3 to the Least-Cost CVP Yield Increase Plan."
  -Pacific Institute. May 1995. "California Water 2020 - A Sustainable Vision."
  -San Joaquin Valley Drainage Program. September 1990. "A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley." Final Report.

Many factors are considered by growers when evaluating the merits of improving irrigation efficiency. The actual savings of water is only one of these factors. In many instances, it does not make economic sense to invest in improved levels of efficient use, because there is insufficient return on investment. In regions where water supplies are less reliable and usually more expensive, it becomes cost effective to improve management and irrigation techniques, to an extent. For a grower, the decision to spend capital will only be made if the capital will be returned over a relatively short period of time. Repayment may be in the form of reduced labor costs, reduced water costs, improved yields, etc. Water users will decide not to implement actions if their "bottom line" will be adversely affected. Social issues also play a role in the decision to implement new measures. For example, many growers use untrained field laborers to irrigate rather than a specially trained irrigator. Also, the generational passing of knowledge (i.e., transfer of control from parent to child) can slow the acceptance of new technologies. For example, a child may want to try new techniques but may not want to challenge the way their parent operates, even if it can be improved upon. Though these issues exist and will be a factor in the rate of acceptance and implementation, they are not assumed to limit the values projected here.

Specific State-wide Assumptions

The assumptions listed here provide the specific basis for estimating loss reduction from improved efficiency. Estimates are based on determinations of:

- existing conditions,
- the CALFED No Action alternative which includes conditions expected with implementation of some on-farm improvements and some Efficient Water Management Practices (EWMPs) and,
- the CALFED solution alternative which includes projections of future conditions that could exist as a result of the CALFED Water Use Efficiency Common Program.

Technical assumptions presented below are categorized into the following:

- on-farm irrigation efficiency improvement
  - existing irrigation efficiency
  - projected irrigation efficiencies under the No Action Alternative
  - additional irrigation efficiency improvements as a result of the CALFED Program
- water delivery improvements by water suppliers
  - existing delivery inefficiencies
  - projected improvement under the No Action Alternative
  - additional improvement as a result of the CALFED Program

On-farm Irrigation Efficiency Improvement

On-farm irrigation efficiency is defined as the volume of irrigation water beneficially used divided by the volume of irrigation water applied (including the change in water stored in the soil). Beneficial uses include crop evapotranspiration, water harvested with the crop, salt removal (leaching), cultural practices, climate control, as well as other minor activities (Burt, etal.). Given these various elements and the difficulty in accurately measuring any one of them, it should be noted that irrigation efficiency is a gross measurement. Values derived are estimates based on best scientific data and should be viewed as a tool to help make management decisions. The information itself can easily be misinterpreted or may be incomplete, resulting in an estimate of efficiency that is not accurate. For example, not including a crop's uptake of irrigation water previously stored in the soil in the total applied water value can make efficiency appear higher than it actually is.

On-farm irrigation efficiency, in more practical terms, is a complex result of the type of irrigation system, the level of irrigation management, the amount of irrigation system maintenance, the method of delivery to the field, the timely availability of water, the climate, the soil, the crop, the irrigator, etc. Irrigation efficiency does not improve simply by changing one of these factors. In fact, some studies have shown that on-farm irrigation efficiency can become worse when, for example, a system type is changed but the management style is not. High levels of irrigation efficiency that are sometimes referred to by agriculture, by the public, and by policy makers can be very misleading since they may reflect regional or mis-calculated efficiencies and not necessarily true on-farm efficiency. In some instances, these high efficiency values actually mean that the crop is being under-irrigated (it is possible to use 100 percent of the applied water beneficially but still under-irrigate). This means reduced yields and the possibility of salt build-up in the soil.

The assumptions presented below for existing and projected on-farm irrigation efficiencies address these issues in more detail and describe the limits of what can be achieved while maintaining optimum agricultural production and a healthy soil environment.

Existing Irrigation Efficiency

Analysis of over 1,000 different field evaluations of on-farm irrigation systems show that state-wide on-farm irrigation efficiency (IE) averages 73 percent (DWR's data, UCD analysis). However, the value can vary significantly from farm-to-farm and basin-to-basin. For each agricultural zone discussed below, information derived from local irrigation system evaluations, farm advisors, local agencies, and other sources, provides an estimate of the average local on-farm irrigation efficiency. This is the baseline efficiency assumed for 1995 conditions. Based on this assumption, projections for improved efficiencies allow estimates to be made of potential reductions in irrigation related losses that may occur in the future.

Care must be taken to only include on-farm irrigation efficiency to eliminate confusion between on-farm and regional efficiency. Regional efficiency is derived from a combination of on-farm efficiencies and the level of regional water reuse, including reuse of deep percolation and tailwater runoff. It is erroneous to draw a comparison between regional efficiency and on-farm efficiency without considering regional reuse, a primary reason for higher regional efficiencies. For example, water lost from one field as tailwater runoff or deep percolation, if water quality is not severely degraded, can be reused on another field for additional beneficial uses. The greater the level of reuse, regardless of the on-farm efficiency of any particular field, the higher the regional efficiency will tend to be.

Projected On-farm Irrigation Efficiencies under the No Action Alternative

Irrigation efficiency is anticipated to improve to between 73 and 80 percent as a result of existing trends in growers' irrigation systems and management. Efforts by federal, state, and local agencies over the past decade in research and education are also expected to continue to provide new understanding of plant/water/soil relationships which will further aid in improved water management. In addition, there has been a renewed focus on conservation and approval of new funding sources, such as Proposition 204, that will continue to influence efficiency improvements. As a result, for the CALFED No Action alternative, on-farm efficiency is projected to be higher than it is today. Estimates of what may occur are presented here to provide a differentiation between what is projected absent the CALFED Program, or No Action, and what additional improvements may result from the Program's Water Use Efficiency component. This difference will provide the basis for programmatic level impact analysis.

Because of variations from field-to-field and basin-to-basin, it may be useful to consider a range of efficiencies that are reasonably expected. Analysis shows that a range of efficiency between 73 percent and 80 percent is a reasonable target (DWR). (Efficiencies of 73 percent represent full irrigation for an entire field, 80 percent efficiency represents full irrigation on 7/8ths of the field and slight under-irrigation on 1/8.) However, these levels of efficiency will require continuation of technical and financial assistance at levels that exist today, at a minimum.

One of the factors that limits projected on-farm efficiency to 80 percent is a factor called *distribution uniformity*. Distribution uniformity (DU) is the uniformity with which irrigation water is distributed to different areas in a field (Burt, etal.). Distribution uniformity is primarily affected by five main factors:

- system manufacturing (e.g., nozzle size, material durability, performance reliability),
- system design (e.g., number of emitters per tree, spacing of sprinklers, size and spacing of furrows),
- system maintenance (e.g, nozzle replacement, land grading, drip system chlorination), and
- system management (e.g., how well a grower operates the system in comparison to the needs of the crop)
- local physical and environmental conditions (e.g., the soil, terrain, and climate)

Most experts in the field of irrigation maintain that current hardware design and manufacturing technology, as well as typical system maintenance activities, limit the DU to around 0.8. The anticipated efficiency improvements under the No Action alternative assume that the majority of irrigators will be able to obtain this level of distribution uniformity. This is necessary to achieve average on-farm efficiencies between 73 and 80 percent without significant under irrigation. Because of the effect that DU can have on irrigation efficiency, increasing on farm efficiency to levels above 80 percent is unlikely without accompanying improvements in DU, especially if soil conditions are to be maintained for optimum crop production.

Additional Irrigation Efficiency Improvements as a Result of the CALFED Program

The CALFED Program's Water Use Efficiency component is expected to extend the level of on-farm efficiency improvement up to 85 percent. Necessary additional improvements will be facilitated by increased levels of technical, planning, and financial assistance, along with increased implementation of EWMPs by agricultural water suppliers (see discussion below under Water Supplier Improvements).

The assumption that allows on-farm efficiencies to increase above 80 percent requires that distribution uniformity (DU) increase to a range of 0.8 to 0.9 by 2020. Analysis of data indicates that an increase of DU to this range for example, can result in applied water reduction of 8 to 12 percent (e.g., about a 3 to 4 inch reduction in applied water on a crop like tomatoes) without any reduction in crop water requirement or any reduction in beneficial uses (DWR). Such improvements could occur through advances in design and manufacturing of pressurized hardware along with increase awareness and implementation of irrigation system maintenance. Figure 4-4 shows relationships between applied water, irrigation efficiency, and improved distribution uniformities. Note that, as the figure demonstrates, reduction in applied water occurs without reduction in beneficial uses (such as crop consumptive use, leaching, and climate control) simply as a result of increased distribution uniformity.

This improvement can occur as a result of combined efforts to improve manufacturing processes and system designs, and efforts by irrigators in improving maintenance and management practices for irrigation systems. It is reasonable to expect these improvements can occur because of increased awareness and necessity for higher efficiency resulting from the CALFED Bay-Delta Program and response by the irrigation industry.

With a higher potential DU, on-farm irrigation efficiencies of 85 percent can be assumed for each agricultural zone. However, it must be recognized that this is a maximum level for maintaining optimum crop production. Efficiencies beyond this level can result in under-irrigation, salt accumulation in the soil, and lower crop yields per unit of applied water, rather than actual improvements in the overall use of the water. In some instances, particular climate, soil and cropping conditions may allow greater efficiencies to be achieved, but only to a nominal extent when compared to the average farming condition.. Average efficiencies would be expected to range from the current statewide average of 73 percent up to a maximum 85 percent. For comparison purposes, it is assumed:

- the maximum on-farm irrigation efficiency projected for the No Action alternative is estimated at 80 percent.
- the maximum on-farm irrigation efficiency projected for a CALFED alternative is estimated at 85 percent.

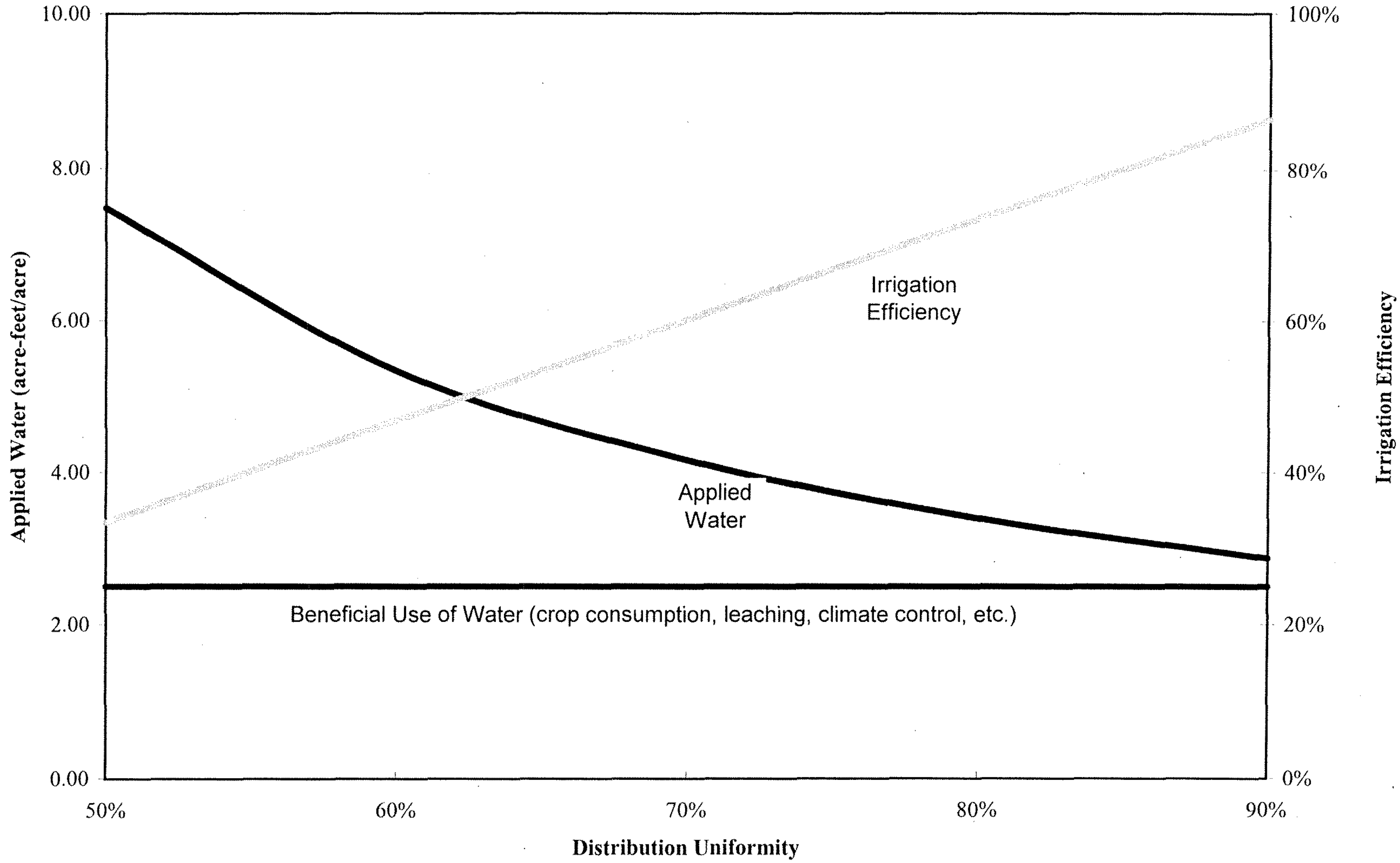


Figure courtesy of DWR

CALFED Bay-Delta Program
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Figure 4.4
Effect of Improved Distribution Uniformity on Potential Seasonal Irrigation Efficiency and Applied Water

Improvements in distribution uniformity can result in increased efficiency and decreased applied water while still meeting beneficial crop needs.

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Water Delivery Improvements by Water Suppliers

The majority of water applied to fields is obtained from water districts, which obtain most of their water from surface diversions (DWR, 1994a). Surface water supplies are actively distributed and delivered to fields and farms within a district's service area. This has been the primary job of the water district for many years. Only recently, has the job of the district begun to change from that of only water delivery to a role of water supply management. It can be noted that districts that typically have limited water supplies and/or high water costs have already taken on the role of water management. Other districts, especially those with ample supplies, still maintain the "delivery only" paradigm. The CALFED Program's Water Use Efficiency component will increase the availability of planning assistance, technical assistance, and funding so that more districts can expand their role to include water supply management, not just delivery.

Distribution of large quantities of surface water is inherently difficult and challenging. In contrast to urban water deliveries, most agricultural water supplies are not pressurized or available "on-demand". (Research to provide "on-demand" supplies is underway but such delivery methods are currently often cost-prohibitive). Instead, large networks of pipelines or open canals rely on gravity to distribute the water. Some of the water districts in California have new, more manageable systems, but many others have gravity systems originally constructed during the early part of this century. Many of these existing water delivery systems need to be upgraded to improve the ability of the district to meet more sophisticated needs of their customers, the end user.

Existing Delivery Inefficiencies

Like on-farm systems, district delivery inefficiencies are a result of the type of system, the availability of water, the climatological conditions, the management, and the maintenance. Losses incurred while delivering water result primarily from four sources:

- conveyance seepage,
- canal spillage,
- gate leakage, and
- conveyance consumption.

Conveyance seepage originates from water supplier channels and reservoirs whose seepage flows directly to groundwater bodies. Canal spillage includes discharges from district end points and drainage courses and can flow to either surface or groundwater bodies. Gate leakage is water that leaks through the last gate or check structure of a water supply channel. The location of the last gate can vary along the channel with daily demands. Gate leakage is typically small and, as such, usually seeps through channel bottoms into groundwater bodies or evaporates. Conveyance consumption represents consumptive uses of water along supply channels and reservoirs including evaporation from water surfaces and evapotranspiration of riparian and bank vegetation (DOI, 1995).

Estimates of existing losses resulting from inefficiencies are presented later for each agricultural zone. Values are based upon information from the *Least-Cost CVP Yield Increase Plan* (DOI, 1995) and its supporting appendices. These estimates of existing conditions are used to estimate the potential for reduction in these losses.

Projected Improvement under the No Action Alternative

Recent efforts by agricultural water suppliers, environmental interest groups, and other interested parties have resulted in the development of the *Memorandum of Understanding Regarding Efficient Water Management Practices by Agricultural Water Suppliers in California*. This MOU is designed to create a constructive working relationship between these groups and to establish a dynamic list of efficient water management practices (EWMPs) for implementation by water suppliers. The goal is to voluntarily achieve more efficient water management than currently exists.

It is anticipated that many agricultural water suppliers will sign the MOU and complete the planning requirements. However, implementation levels of EWMPs may occur below the maximum potential. This is based, in part, on resource limitations (both dollars and people) currently experienced by most districts and lack of interest in participating by some water suppliers. The CALFED Water Use Efficiency component includes planning and technical assistance, as well as additional funding, designed to address these shortcomings.

There are just over 8.5 million acres of irrigated lands in the CALFED Program's geographic scope. With the MOU being finalized at the start of 1997, 29 water suppliers representing over 2.9 million acres have already signed. However, current signatories represent about 30 percent of the potential. Assuming that the number of water suppliers may double by 2020, those signing the MOU may add up to around 4 to 5 million acres.

For purposes of the No Action alternative, it is estimated that voluntary efforts by suppliers representing about 4 to 5 million acres, or 50 percent of the land, will result in attaining 60 percent of the water supplier improvements estimated in the *Least-Cost CVP Yield Increase Plan* (DOI, 1995) and its supporting appendices. This should represent a modest level of planning, adoption and implementation of efficiency measures consistent with the anticipated level of participation in the MOU. Yet, this does not assume that all signatories will achieve implementation of all that is feasible and cost-effective.

Additional Improvements as a Result of the CALFED Program

The Program's Water Use Efficiency component is anticipated to provide the assistance necessary to gain higher levels of EWMP implementation and by more agricultural water districts. Incentives, coupled with regulatory triggers, will encourage more districts to properly examine the benefits of the EWMPs and implement those that are cost-effective. It is assumed that such measures will result in a significant majority of the water suppliers planning, adopting, and implementing feasible, cost-effective efficiency measures.

Estimates of the potential reduction in existing losses are presented later for each agricultural zone. For purposes of impact analysis, estimates of loss reduction under the CALFED alternative are based upon attainment of the majority of remaining improvements identified in the *Least-Cost CVP Yield Increase Plan* (DOI, 1995) and its supporting appendices (i.e., remaining improvements above those achieved under No Action).

It is important to recognize, though, that these estimates are for the sole purpose of programmatic level impact analysis and should not be used for any planning purposes.

Irrecoverable vs. Recoverable Losses

With the exception of a negligible amount of water required for plant metabolic processes, agricultural applied water can be accounted for by the various demand elements presented in Figure 4-5. The "consumptive" elements (ET_{crop}, on-farm evaporation, and conveyance consumption) are lost to the atmosphere and generally not recovered.

Tailwater, deep percolation, conveyance seepage, canal spill, and gate leakage flow either to surface or groundwater bodies and may be recoverable. In theory, all these losses are recoverable. In practice, however, losses that flow to very deep aquifers or excessively degraded water bodies may not be recoverable because of prohibitively expensive energy requirements (i.e., they become irrecoverable). Determining recoverability varies with location and time as well as other factors (DOI, 1995).

Distinguishing between irrecoverable and recoverable losses is typically based solely on water quality considerations. This assumes that all losses to usable water bodies can be economically recovered. Principal water bodies that are regarded as irrecoverable include saline, perched groundwater underlying irrigated land on the west side of the San Joaquin Valley, the Salton Sea, which receives drainage from Coachella and Imperial Valleys, and the ocean.

Real water savings can only be achieved by reducing irrecoverable losses because they are truly lost from the system. Water is considered "saved" when these losses are reduced. Recoverable losses, on the other hand, often constitute a supply to the downstream user. Downstream uses can include groundwater recharge, agricultural and urban water use, and environmental uses, including wetlands, riparian corridors, and instream flows. Often, recoverable losses are used many times over by many downstream beneficiaries. To reduce these losses would deplete such supplies with no net gain in the total water supply. They do, however, provide significant opportunities to contribute to the achievement of other CALFED objectives such as:

- improve instream and groundwater quality through reduced deep percolation or runoff of water laden with residual agricultural chemicals, sediments, and naturally occurring toxicities,
- reduce temperature impacts resulting from resident time of water on fields prior to runoff returning to surface waters,
- reduce entrainment impacts to aquatic species as a result of reduced diversions, and
- reduce impacts on aquatic species, especially anadromous fish, through minor modifications in diversion timing and possibly provide in-basin benefits through subsequent modifications in the timing of reservoir releases.

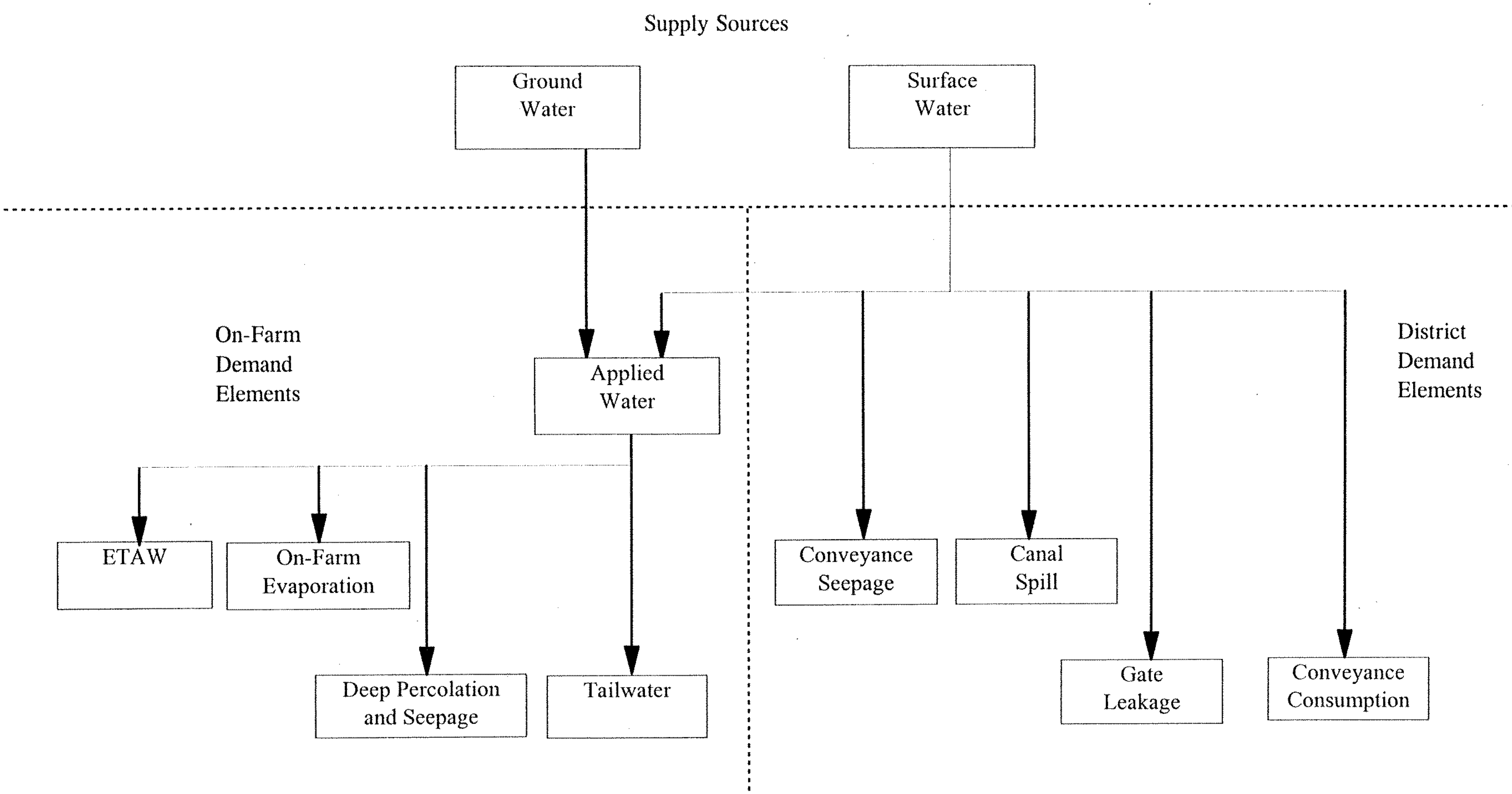


Figure courtesy of the Bureau of Reclamation - Mid Pacific Region from the *Demand Management Technical Appendix #3* to the *Least-Cost CVP Yield Increase Plan*

Figure 4.5

Demand Elements

Water supplied to agricultural fields can result in one of several demand elements. The efficiency of delivery and application systems dictates how much goes to each element.

In general, the same water use efficiency measures are implemented to reduce recoverable losses as are used for reducing irrecoverable losses. The only purpose for separating the two is because of their difference in ability to generate water supplies that can be reallocated. Recoverable losses are available for subsequent in-basin use, and may provide environmental benefits. Reallocation of recoverable losses to out-of-basin uses could result in impacts to other diverters or the environment. This is described in more detail below under *Hydrologic Interconnections*.

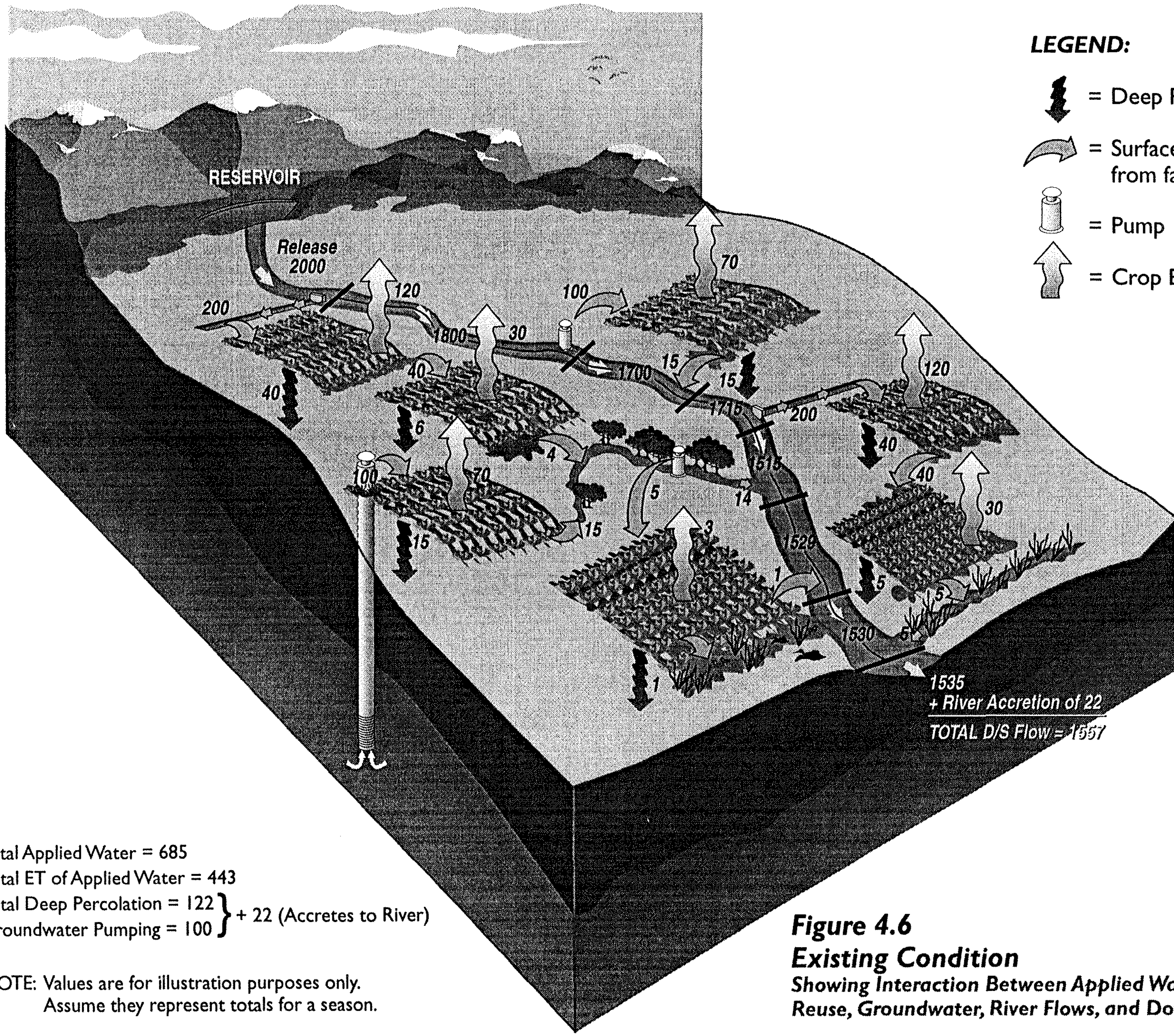
As previously stated, it is assumed that on-farm efficiency may improve to 80 percent under a No Action alternative, given current trends and significant technical and financial input. This is assumed to increase up to 85 percent under the CALFED alternative resulting in total reductions in losses between 8 and 12 percent of applied water.

Though the reduction in applied water can seem significant, the benefit to water quality or the ecosystem is not necessarily one-for-one. For example, an 8 to 12 percent reduction in applied water does not imply that the same percentage improvement in water quality would result. Results could be greater or less, depending on local circumstances. For example, applied water reductions may be assumed to be spread throughout an irrigation season while water quality impacts that accompany the irrigation may be concentrated in particular days or months or under particular flow conditions. The benefit of reducing applied water may have only minimal benefits during certain periods but more significant benefits during other periods.

It is assumed that implementing efficiency improvements will not result in redirected impacts to the water user or water supplier. For example, an efficiency measure would not be implemented to reduce applied water if the water user saw production costs increase but received no direct benefit. However, the influence of outside interests to offset local impacts such that there is a "win-win" situation is assumed to occur when appropriate. Outside participation in planning, funding and implementation can help make efficiency measures locally cost-effective when they otherwise might not be. Benefits are also assumed to be shared when costs are shared, whether gained by the water user, the water supplier, or the environment. As discussed in Chapter 2 of this appendix, one of the Agricultural Water Use Efficiency Actions is *Management Improvements to Achieve Multiple Benefits*. This action is intended to help identify and implement such opportunities, expanding on processes contained in the Agricultural MOU.

Hydrologic Interconnections

The primary reason that the reduction of recoverable losses does not generate a water supply for reallocation is because of the complex hydrologic interconnections that occur between surface water, groundwater, stream flows, and losses associated with irrigation. Figure 4-6 illustrates a generic "existing condition" for some areas of the Central Valley. Figures 4-6 and 4-7 are used as the basis for a discussion regarding hydrologic interconnections.



LEGEND:

= Deep Percolation

= Surface Flow to or from farm fields

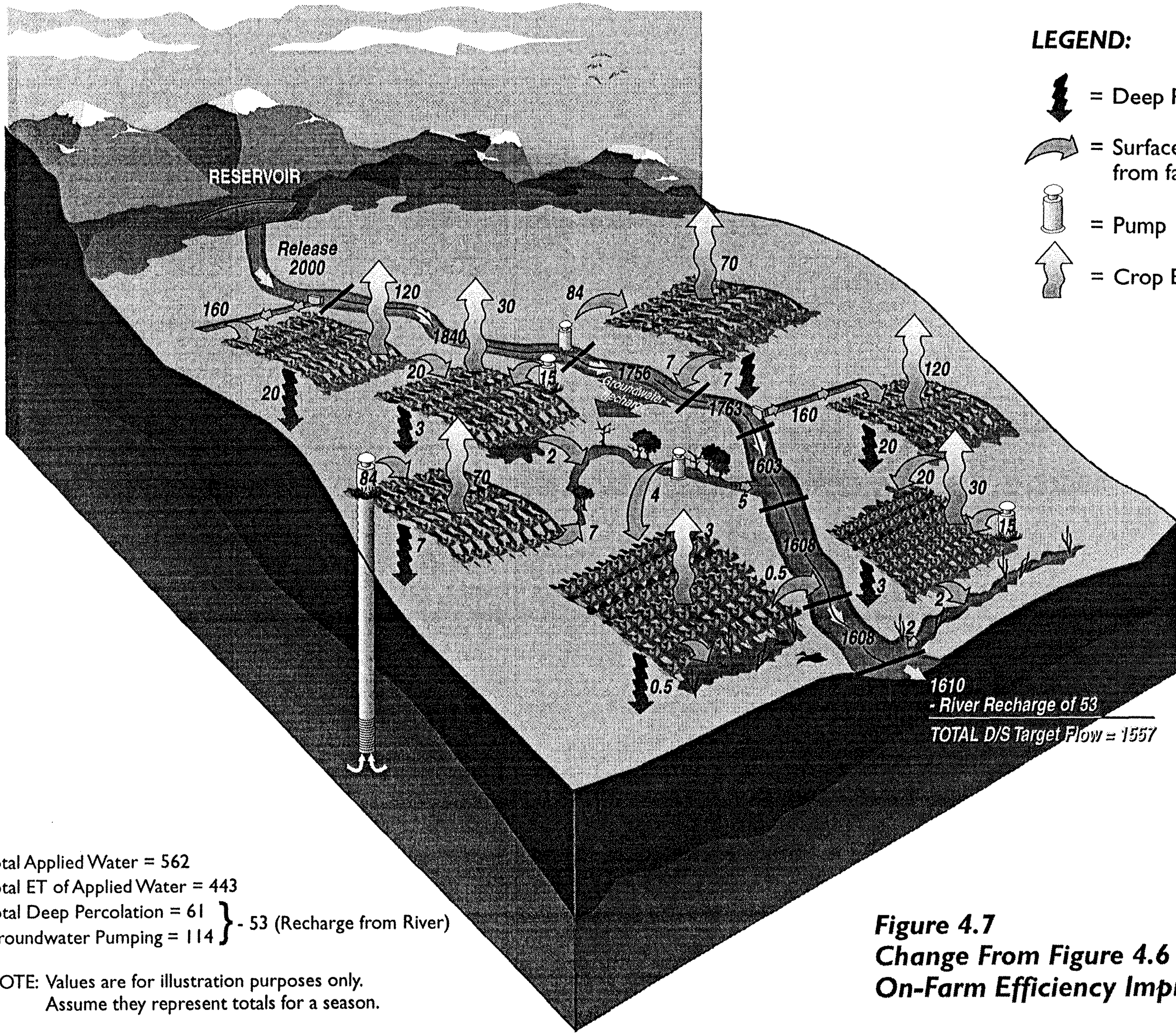
= Pump

= Crop Evapotranspiration

Total Applied Water = 685
Total ET of Applied Water = 443
Total Deep Percolation = 122 } + 22 (Accretes to River)
Groundwater Pumping = 100 }

NOTE: Values are for illustration purposes only.
Assume they represent totals for a season.

Figure 4.6
Existing Condition
Showing Interaction Between Applied Water, Beneficial Uses, Reuse, Groundwater, River Flows, and Downstream Target Flow.



LEGEND:

= Deep Percolation

= Surface Flow to or from farm fields

= Pump

= Crop Evapotranspiration

Total Applied Water = 562
Total ET of Applied Water = 443
Total Deep Percolation = 61 }
Groundwater Pumping = 114 } - 53 (Recharge from River)

NOTE: Values are for illustration purposes only.
Assume they represent totals for a season.

Figure 4.7
Change From Figure 4.6 Resulting From On-Farm Efficiency Improvements

In general, if efficiency is improved, indirect use of "losses" by subsequent users will decline, but direct use of water by those subsequent users will increase. Therefore, the basin's hydrology remains relatively stable. To most simply present this principle on the accompanying figures, several assumptions are made, including:

- crop evapotranspiration does not change (i.e., no crop modifications or land fallowing),
- cumulative target flows downstream remain constant for a given period of time (i.e., February through September cumulative demands do not change regardless of upstream activities), and
- long-term groundwater levels remain in balanced conditions.

These assumptions are reasonable, especially for basins such as the Sacramento Valley and agricultural areas along the eastern side of the Central Valley. For example, it is quite likely that growers could improve on-farm irrigation efficiency but not change the types of crops grown. In addition, seasonal downstream demands usually remain fairly constant regardless of what occurs upstream since they are driven by Delta outflow and export demands. Also, groundwater and surface water interaction is governed by rules of hydrology. When groundwater elevations are lower than river elevation, a river typically will recharge groundwater. Conversely, groundwater will add to a river's flow when it is higher than the river elevation, referred to as accretion.

The interaction between ground and surface water, however, can be slow depending on the local geologic and hydrologic conditions. Delays of days, weeks, months or even years can erroneously be interpreted as water savings when in fact there are none. If the false savings are redirected out of a basin, overdraft of the groundwater resources and loss of instream flows can result. In areas that are not experiencing overdraft, the natural process of depletion and accretion usually can maintain a relative balance. For illustration purposes, this balance is assumed to occur within the same season, though multi-year benefits could sometimes be gained (i.e., through conjunctive use projects), but possibly at the risk of reducing water supplies for other purposes, including high winter flows flowing out to the sea.

As shown on Figure 4-6, releases are made from a reservoir to meet local diversions, instream uses and downstream target demands. The fields in the area obtain water for crop needs by various methods including delivery via a canal diversion, direct river diversion, direct diversion from drainage, and groundwater pumping. As illustrated with the various flow arrows and accompanying quantities (units are not necessary for this example but could be assumed as 1,000's of acre-feet), "losses" resulting from over-application of water go to either surface runoff or deep percolation. In addition to natural recharge, the deep percolation acts to recharge the aquifer. Surface runoff either returns directly to the river, to the river via a drainage course, or to another field. A simple water accounting is shown along the river as diversions remove water, and surface runoff returns water. In this example, a balance between deep percolation and groundwater pumping creates a slight surplus of deep percolation. It is assumed that this additional groundwater actually results in river accretion (groundwater naturally flowing back into the river) by the end of this hypothetical stream reach.

Figure 4-7, by contrast, assumes that on-farm efficiency improvements are implemented, resulting in decreased river diversions. Crop demands do not change. The reduced diversions could be interpreted as "real" water savings. However, reduced diversions really are the result of decreased deep percolation and decreased surface runoff- water that was being indirectly used for other existing beneficial uses. To continue to meet crop needs, fields that depended on surface runoff for their supplies have now added new wells. The result is that indirect reuse that was occurring in Figure 4-6 from surface runoff and deep percolation now occurs through increased direct groundwater pumping.

Increased pumping, coupled with decreased deep percolation results in lower groundwater levels. When this happens, the river will naturally allow more water to recharge into the ground to maintain the balance (river depletion). With natural balancing and the need to maintain downstream target quantities, the seasonal reservoir releases remain the same as occurred under existing condition. No net decrease in seasonal water use has occurred.

What does change is the seasonal management of water. For example, the seasonal quantity of water instream is higher in Figure 4-7 than under existing conditions, and surface return flows as well as direct stream diversions have been reduced. Indirect use has been changed to manageable, direct use.

The focus should be placed on the benefit from each unit of water not on the unit of water itself. Changing to more manageable direct use can provide benefits desired by CALFED. When comparing the two figures, the reduced diversions can reduce aquatic species entrainment, and reduced return flows can result in better instream water quality, though maybe impacting drainage habitat at the same time. In addition, the increased instream flows can be re-regulated and released from reservoirs to correspond to fishery or other aquatic habitat needs (e.g., fish attraction or out-migration flows) rather than for irrigation demands. This is not a water supply that can be reallocated out-of-basin, however.

These important benefits can be gained through efficiency improvements with no adverse impact to local users. However, local users may not be able to justify the cost of implementing efficiency measures when compared to the local benefit they may see. Thus, outside assistance may be necessary to help realize the more regional or global benefits from improved local water use management and efficiency.

There are a number of different scenarios other than what is shown on Figure 4-7 that could be developed to show how hydrologic elements are interconnected. For example, instead of increased groundwater pumping, a new surface water link could be directly routed to the fields from the river or from an existing canal diversion. This may help groundwater levels remain high and reduce river recharge but increase total diversions. Or, a new diversion could be constructed downstream and water pumped back upslope to each of the fields with existing river diversions abandoned. This may reduce diversion impacts from a particular sensitive reach of the stream, but not change total diversions. Each of these scenarios would create different benefits and impacts. For example, pumping water back upslope would require more energy compared to using a gravity based system. The array of possibilities underscores the importance to analyze each opportunity individually. What works well in one location may be detrimental in another.

Assessing Benefits From a Basin-wide View

It is important to note that in some instances water associated with irrecoverable losses provides a benefit and conservation of the losses could be detrimental. For example, agricultural drainage flow in the Imperial Valley currently flows to the Salton Sea. As stated above, these flows are considered irrecoverable losses because of their unavoidable degraded quality, in this case, as a result of leaching salts from the soil profile. However, they serve an important role in providing necessary dilution water for toxic drainage inflow from other sources, such as the New River, flowing to the Salton Sea from Mexico. In addition, they provide relatively fresh water to help maintain lake salinity and elevation levels.

Another example of irrecoverable losses providing a benefit is in the Salinas Valley. This area is currently experiencing sea water intrusion into inland areas. The result is contamination of groundwater and associated wells with salty ocean water. Deep percolation resulting from inefficiencies helps maintain high groundwater levels that act to hold back the intrusion of sea water.

All aspects of a basin's hydrology should be taken into consideration as part of on-farm and district level improvements. Analysis should be undertaken using basin-wide approaches that look for net benefits. These efforts will be assisted through the actions outlined previously in Chapter 2.

Regional Reduction Estimates

Estimates of the results of efficiency improvements are presented here for each of the agricultural zones defined previously in Section III, *Determination of Geographical Zones*. The values presented are only intended to provide input for purposes of a programmatic level impact analysis. These are estimated goals, not required targets, and should not be used for planning purposes. Estimates of potential reduction in losses from on-farm and district-level efficiency improvements are presented under one of two categories:

- Estimated Real Water Savings for Reallocation to Other Water Supply Uses
  - existing conditions (on-farm, district)
  - No Action conditions (on-farm, district)
  - CALFED conditions (on-farm, district)

- Estimated Applied Water Reduction for Multiple Benefits
  - existing conditions
  - No Action conditions
  - CALFED conditions

Estimated real water savings (reduced irrecoverable losses) can be viewed as a source of water that can be reallocated to other purpose such as improved local agricultural supply reliability, offsetting of local groundwater overdraft, or a transfer to other beneficial water supply uses, including the environment. Estimated applied water reductions do not generate a reallocable supply, but do provide other benefits desired by the CALFED Program.

As stated, water use efficiency improvements can result in reduction in applied water of 8 to 12 percent. Potential applied water reductions are included here for eight of the nine agricultural zones. Reductions in the Colorado River Region would not directly translate to water quality or ecosystem benefits in the Bay-Delta watershed, and are therefore not included. Similarly, reduction of losses in the zones that import water from the Bay-Delta but are not tributary to the Delta (South Coast, Central Coast, and San Francisco Bay regions) can only provide an ecosystem benefit through reductions in diversions or modified diversion timing. They cannot benefit water quality because irrigation return flows do not re-enter the Delta watershed. The Tulare Lake Region can provide ecosystem and water quality benefits to the Delta watershed through savings associated with deliveries from the Friant system. Other export areas whose irrigation return flows do re-enter the watershed can provide water quality as well as ecosystem benefits to the Delta.

AG1 - Sacramento River

Overview

The Sacramento River region is defined by the Sacramento Valley, from Sacramento north to Redding. The area is predominantly in agriculture but many growing communities are within its boundary, including the greater metropolitan areas of Sacramento. All rivers that flow into the valley are carried by the Sacramento River southward to the Sacramento-San Joaquin Delta. Here, surface flows head west to the Pacific Ocean. With abundant surface and groundwater resources, agriculture in this region experiences few water shortages. Water users in the Sacramento Valley have some of the oldest rights to surface water, with some dating back to the gold rush era. Agricultural water use comprises about 58 percent of the region's total water use.

Typically, losses associated with agricultural water use in this region tend to return to the system of rivers, streams, and aquifers. Reuse of these losses is widely practiced. The region does not have significant irrecoverable losses, although water quality degradation does occur. Much of the region's groundwater resources are recharged by annual over-irrigation and deep percolation of applied water. This water is pumped by many of the areas agricultural lands that are irrigated solely with groundwater. In addition, tailwater from fields typically returns to streams and becomes part of the instream flow diverted for another farm, wetland, or city somewhere downstream.

Agricultural production is anticipated to remain constant into the future with no significant decreases resulting from the urbanization of areas around Sacramento. New land brought into production is expected to offset any loss of land to urbanization.

Agricultural Information

Types of crops grown:	rice, trees, tomatoes, corn, sugar beets, some truck crops, alfalfa and pasture.
Irrigated Land:	approx. 1,700,000 acres
Types of irrigation systems in use:	About 70% of the area is under surface irrigation (e.g., furrow or border). Drip/micro systems are more prevalent on trees but constitute only a small portion (<10%)
Existing average on-farm irrigation efficiencies:	73%, as estimated by DWR

Average applied water: approx. 6,500,000 acre-feet annually

Source of Water:

-groundwater, about 1/4 of the supply.
-surface water from the Sacramento, Feather, and American Rivers and various tributaries. Surface water is diverted at multiple points, both by individuals and by water districts. Water is stored in numerous reservoirs and released based mostly on agricultural demands.
-reuse of losses is an important feature in this area with all deep percolation and tailwater runoff being recovered and reused for some beneficial use.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses

As discussed above, the Sacramento River region is characterized as only having recoverable losses. Therefore, the Sacramento River region has no potential water savings that can be reallocated to other beneficial water supply uses. It is true, however, that potential exists to improve efficiencies for other purposes, namely improved water quality, changed timing of flow releases, and reduced fishery impacts. These are covered below under *Estimated Applied Water Reduction for Multiple Benefits*.

Estimated Applied Water Reduction for Multiple Benefits

Values shown in the table below are estimated reduction in applied water as a result of on-farm efficiency improvements that reduce recoverable losses. These reductions have the ability to benefit water quality, flow timing, and the ecosystem.

	Average Existing Applied Water (1,000 af/yr)	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction (1,000 af/yr)
Sacramento	6,500	200-310	320-470	520-780

AG2 - Delta

Overview

The Delta region is characterized by a maze of tributaries, sloughs, and islands encompassing 738,000 acres. Lying at the confluence of California's two largest rivers, the Sacramento and the San Joaquin, it is a haven for plants and wildlife. Islands, protected from Delta waters by an extensive levee system, are used primarily for irrigated agriculture. The vast majority of the 500,000 acres of irrigated land in the Delta derive their water supply directly by diverting water from the adjacent tributaries, rivers and sloughs. Agricultural land use is anticipated to decline in the future as a result of other CALFED ecosystem restoration activities.

The Delta region is bounded on the north by the metropolitan area of Sacramento, and on the south by the city of Tracy. The west is bounded by Chipps Island near the true confluence of the Sacramento and San Joaquin Rivers. There is very little urban land use in the Delta. There are, however, a few small farming communities.

Local Delta water use is protected by a number of measures, such as the Delta Protection Act, the Watershed Protection Law, and water rights. Most water users have the right to divert water for beneficial uses on their land under the riparian water rights doctrine. Water diverted and applied to fields, but not consumed typically is collected in drains and pumped back into the Delta waterways. Because of this recycling of losses, the potential to generate actual water savings available for reallocation to other beneficial uses is non-existent.

Agricultural Information

Types of crops grown:	tomatoes, corn, sugar beets, some truck crops, alfalfa and pasture.
Irrigated Land:	approx. 500,000 acres
Types of irrigation systems in use:	Most of the area is under surface irrigation (e.g., furrow or border). Some use of hand-move sprinklers also occurs, but primarily for pre-irrigation and germination.
Existing average on-farm irrigation efficiencies:	73 percent, as estimated by DWR
Average applied water:	approx. 1,300,000 acre-feet annually

Source of Water: -groundwater, very limited use.
-surface water is pumped directly from the Delta waterways.
-reuse of losses is an important feature in this area with tailwater runoff being pumped off each island back into Delta waterways.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses

As discussed above, the Delta region is characterized as having only recoverable losses. Therefore, the region has no potential water savings that can be reallocated to other water supply uses. It is true, however, that potential exists to improve efficiencies for other purposes, namely improved water quality, and reduced fishery impacts. Since most Delta water users have riparian water rights, there is no ability to modify timing of flow releases as a result of efficiency improvements. Efficiency improvements resulting in reduced diversions could only result in water quality or fishery related benefits. These are covered in more detail under *Estimated Applied Water Reduction for Multiple Benefit* below.

Estimated Applied Water Reduction for Multiple Benefits

Values shown in the table below are estimated reduction in applied water as a result of on-farm efficiency improvements that reduce recoverable losses. These reductions have the ability to benefit water quality, flow timing, and the ecosystem.

	Average Existing Applied Water (1,000 af/yr)	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction (1,000 af/yr)
Delta	1,300	40-60	60-90	100-150

AG3 - Westside San Joaquin River

Overview

The Westside San Joaquin River region is bounded by Tracy on the north, the farming town of Mendota to the south and the San Joaquin River to the east. Agriculture is the predominant feature in this region with only a handful of small farming communities. Other than the San Joaquin River running along the eastern border, there are no major rivers that provide surface water to the region. Most of the region's agriculture is supported by water exported through the California Aqueduct and the Delta Mendota Canal. These two canals are predominant features that run south through this region. Agricultural acreage is not anticipated to decline much in this area, other than what may result from higher water costs, some urbanization, and limited land retirement.

Toward the southern end of this region, referred to as the Grasslands area, agricultural drainage has become an increasing problem. Combinations of salts, imported by the canals, and naturally occurring trace minerals, such as selenium, have generated concern with drainage from agricultural fields. Some of this drainage results in deep percolation to shallow groundwater. This in turn has caused degradation of the shallow groundwater, limiting potential reuse. Several studies have been completed or are underway to find solutions to the drainage problems, including efforts by the CALFED Program. It is anticipated that these efforts will result in source control measures, increased directed reuse of drain water on salt tolerant crops (agroforestry), and possibly some land fallowing or land retirement. The source control measures will include improvements in on-farm irrigation efficiency, as well as other measures.

Agricultural Information

Types of crops grown:	cotton, tomatoes, corn, sugar beets, some truck crops, trees, vines, grain, pasture and alfalfa.
Irrigated Land:	approx. 430,000 acres
Types of irrigation systems in use:	Most of the area is under surface irrigation (e.g., furrow or border). Hand move sprinklers are being used in combination with surface systems. Micro/drip systems are increasing in use for some row crops, such as peppers and tomatoes, and on trees.
Existing average on-farm irrigation efficiencies:	73 percent, as estimated by DWR

Average applied water:	approx. 1,400,000 acre-feet annually
Source of Water:	-groundwater is used extensively in the northern part of the region but is limited because of degradation in the southern portion. -surface water is delivered primarily via the California Aqueduct or Delta Mendota Canal. Some surface water is delivered in exchange for San Joaquin River water. -reuse of surface losses occurs regularly. Deep percolation, if not lost to degraded groundwater, is also reused.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses

	Existing Irrecoverable Loss (1,000 af)	Projected Reduction under No Action (1,000 af)	Additional Reduction under CALFED (1,000 af)	Total Reduction (1,000 af)	Remaining Future Irrecoverable Loss (1,000 af)
On-farm	30-40	3-5	20-30	23-35	5-7
District	20-25	5-10	10-15	15-25	0-5
Total	50-65	8-15	30-45	40-60	5-15

Estimated Applied Water Reduction for Multiple Benefits

Values shown in the table below are estimated reduction in applied water as a result of on-farm efficiency improvements that reduce recoverable losses. These reductions have the ability to benefit water quality, flow timing, and the ecosystem.

	Average Existing Applied Water (1,000 af/yr)	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction [1] (1,000 af/yr)
West SJR	1,400	25-45	40-70	65-115

1. Totals have been adjusted to exclude any estimated irrecoverable losses presented previously. These estimated reductions do not create an increased water supply, only water quality and ecosystem benefits.

AG4 - Eastside San Joaquin River

Overview

The Eastside San Joaquin River region encompasses the area from the San Joaquin River near Fresno north to the Cosumnes River, and from the eastern foothills to San Joaquin River as it travels up the valley to the Delta. This area is predominantly agricultural but includes the metropolitan areas of Stockton, Modesto, and Merced along with numerous other communities. Several rivers originating in the Sierra Nevada flow out of the mountains and west into the San Joaquin River (as it travels through the center of the valley). These include the Merced, Tuolumne, Stanislaus, and Mokelumne Rivers as well as other small tributaries. Natural flows and excellent water quality have provided ample supplies to the agricultural users on the eastside of the valley.

Losses associated with applied water typically recharge groundwater or return to surface waterways. Either way, they are available again for other beneficial uses. Irrecoverable losses are almost non-existent. However, some degradation of shallow groundwater does occur as a result of deep percolation of salts and trace elements. This primarily occurs in the southern portion of this region and at the bottom of the valley trough.

Many of the local water districts have very firm water rights dating back to the turn of the century. Some water is imported into the region via the Madera Canal. This water is diverted from the San Joaquin at Millerton Lake and routed north to irrigate lands in Madera County. Otherwise, there are no major out-of-basin deliveries of water (as occurs in export regions). Agricultural acreage is anticipated to decline slightly in this region as a result of increased urbanization.

Agricultural Information

Types of crops grown:	tomatoes, corn, sugar beets, some truck crops, trees, vines, alfalfa and pasture.
Irrigated Land:	approx. 1,270,000 acres
Types of irrigation systems in use:	Most of the area is under surface irrigation (e.g., furrow or border). Micro/drip systems are increasing in use for trees and vines.
Existing average on-farm irrigation efficiencies:	73 percent, as estimated by DWR
Average applied water:	approx. 4,000,000 acre-feet annually

Source of Water:	-groundwater, used for < 1/4 of the water supply needs. An overdraft of approx. 200,000 acre-feet occurs annual, primarily in San Joaquin and Madera counties. -surface water primarily originates in the Sierra Nevada and is of high quality. It is used for the majority of irrigation needs, -reuse of losses is an important feature in this area with most losses either recharging the groundwater or returning to surface waterways.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses

As discussed above, the Eastside San Joaquin River region is characterized as primarily having recoverable losses. The region has very limited potential water savings that can be reallocated to other beneficial water supply uses.

	Existing Irrecoverable Loss (1,000 af)	Projected Reduction under No Action (1,000 af)	Additional Reduction under CALFED (1,000 af)	Total Reduction (1,000 af)	Remaining Future Irrecoverable Loss (1,000 af)
On-farm	4-6	1-3	1-2	2-5	1-2
District	1-2	0-1	0-1	0-2	0-1
Total	5-8	1-4	1-3	2-7	1-3

Estimated Applied Water Reduction for Multiple Benefits

Values shown in the table below are estimated reduction in applied water as a result of on-farm efficiency improvements that reduce recoverable losses. These reductions have the ability to benefit water quality, flow timing, and the ecosystem.

	Average Existing Applied Water (1,000 af/yr)	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction [1] (1,000 af/yr)
East SJR	4,000	125-190	190-285	315-475

1. Totals have been adjusted to exclude any estimated irrecoverable losses presented previously. These estimated reductions do not create an increased water supply, only water quality and ecosystem benefits.

AG5 - Tulare Lake Basin Sub-Area

Overview

The Tulare Lake region includes the southern San Joaquin Valley from the southern limit of the San Joaquin River watershed to the base of the Tehachapi Mountains. The area is predominantly agricultural, but many small agricultural communities as well as the rapidly growing cities of Fresno and Bakersfield are located here. The Kings, Kaweah, Tule, and Kern Rivers flow into this region from the east. All of the rivers terminate in the valley floor, and do not drain to the ocean except in extremely wet years. This means there is also no outlet for drainage flows originating on-farm. This area is a closed basin.

Because most of the source water is of very high quality, both surface and subsurface agricultural drainage is extensively reused, except along the western slope of the basin. In fact, artificial recharge of groundwater basins, known as groundwater banking, occurs in many areas of the Tulare Lake basin. This practice is likely to increase in future years as combined management of surface and groundwater sources becomes more essential.

Though, because of the closed-in nature of the basin (there is no drainage outlet except in very wet periods), salinity build-up in the soils does occur. As water is reused and natural salts present in the irrigation water are leached from the soil, the drainage water does become increasingly salty. Several evaporation ponds have been constructed in portions of the basin to collect and evaporate this saltier drainwater. Drainage problems tend to occur only along the western slope of the basin and around the historic Tulare Lake bed. It is in these areas the conservation of irrecoverable losses has some potential.

Irrigated agriculture accounts for about 95 percent of the water use in the region. In the future, it is anticipated that increased urbanization, and increasingly high costs for water could reduce the variety and acreage of crops being produced, and thus, the amount of agricultural water use (DWR, 1994a).

Agricultural Information

Types of crops grown:	Cotton, tomatoes, trees, row crops, truck crops, vines. Double cropping of some crops also occurs.
Irrigated Land:	approx. 3,200,000 acres
Types of irrigation systems in use:	About 70 percent of the area is under surface irrigation (e.g., furrow). Drip/micro systems are more prevalent on trees and vines but are also being

	used on some row crops.
Existing average on-farm irrigation efficiencies:	75 percent as estimated by DWR
Average applied water:	approx. 9,300,000 acre-feet annually
Source of Water:	-groundwater, including a 500,000 to 600,000 acre-foot annual overdraft. -surface water from Kings, Kaweah, Tule, and Kern Rivers and imported supplies from the Friant-Kern system and the California Aqueduct. -reuse of losses is an important feature in this area with more than 75 percent of deep percolation being recovered and reused.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses

	Existing Irrecoverable Loss (1,000 af)	Projected Reduction under No Action (1,000 af)	Additional Reduction under CALFED (1,000 af)	Total Reduction (1,000 af)	Remaining Future Irrecoverable Loss (1,000 af)
On-farm	75-85	15-20	20-25	35-45	35-40
District	20-30	5-10	5-10	10-20	10-10
Total	95-115	20-30	25-35	45-65	45-50

Special Conditions:

Overall, potential savings shown above may intuitively seem low. But as a result of the drought in the late 1980's and early 1990's, the 1994 Bay-Delta Accord, and numerous other elements affecting water supply reliability and cost, irrigation efficiency has further improved, especially in the last 5 years. This has reduced the opportunity for savings that previously existed. For example, previous estimates showed opportunity for 90,000 acre-feet of real water savings in the Tulare Basin hydrologic region. The No Action condition now reflects a potential of only about 25,000 acre-feet. The values shown under *Existing Irrecoverable Loss* also reflects the reduced potential. Additionally, most of the savings accompanying the improvements have been reallocated within the local districts to meet existing unmet demands.

Estimated Applied Water Reduction for Multiple Benefits

Values shown in the table below are estimated reduction in applied water as a result of on-farm efficiency improvements that reduce recoverable losses. These reductions have the ability to benefit water quality, flow timing, and the ecosystem.

	Average Existing Applied Water (1,000 af/yr)	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction [1] (1,000 af/yr)
Tulare	9,300	300-400	400-600	700-1,000

1. Totals have been adjusted to exclude any estimated irrecoverable losses presented previously. These estimated reductions do not create an increased water supply, only water quality and ecosystem benefits.

AG6 - San Francisco Bay

Overview

The San Francisco Bay region is primarily urban with very little agricultural acreage. A 1990 land use survey shows only about 60,000 acres of agriculture in the region (DWR, 1994a). This is a 60 percent reduction in 40 years. Agriculture only uses about 1 percent of the entire region's net water demand (80 percent of net demand is for environmental flows). Agricultural production generally is located on the outskirts of the urban areas and in isolated valleys, such as the Napa, Sonoma, and Livermore valleys. More than half of the agricultural acreage is for wine grapes. It is anticipated that a small portion of the existing irrigated land will be lost to urbanization. However, the ability to grow vines in areas never before irrigated will add new acreage and result in little or no net change.

Because of the location of most of the agriculture, losses associated with irrigation are recaptured through deep percolation or surface runoff to streams and waterways. The region does not have irrecoverable losses associated with irrigated agriculture (urban use is discussed in a separate section).

Agricultural Information

Types of crops grown:	Predominantly vineyards with some truck crops and fruit trees.
Irrigated Land:	approx. 60,000 acres

Types of irrigation systems in use:	Mostly pressurized systems using drip/micro or sprinklers.
Existing average on-farm irrigation efficiencies:	73 percent, as estimated by DWR
Average applied water:	approx. 90,000 acre-feet annually
Source of Water:	-groundwater is a key source for agriculture. -surface water is generated locally as well as imported from various areas, including directly from the Sierra Nevada and from the Delta. -reuse is an important feature in this area. Losses typically recharge groundwater, so there is no irrecoverable water (associated with agricultural use).

Estimated Real Water Savings for Reallocation to Other Water Supply Uses

As discussed above, the San Francisco region is characterized as having only recoverable losses (associated with agricultural use). Therefore, the region has no potential water savings from agriculture that can be reallocated to other beneficial water supply uses. It is true, however, that potential exists to improve efficiencies for other purposes, namely improved water quality, change the timing of diversions, and reduced fishery impacts. These are covered in more detail under *Estimated Applied Water Reduction for Multiple Benefit* below.

Estimated Applied Water Reduction for Multiple Benefits

Values shown in the table below are estimated reduction in applied water as a result of on-farm efficiency improvements that reduce recoverable losses. These reductions have the ability to benefit flow timing, and the ecosystem, but not water quality. Any return flows that may degrade the quality of the receiving water is typically downstream of the Delta.

	Average Existing Applied Water (1,000 af/yr)	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction (1,000 af/yr)
San Francisco	90	3-4	4-6	7-10

AG7 - Central Coast

Overview

The Central Coast region encompasses land on the western side of the coastal mountains that is hydraulically connected to the Bay-Delta region. This includes southern portions of the Santa Clara Valley and San Benito County. Most of the agricultural water supplies are generated within the region. However, about 50,000 acre-feet of Delta waters are exported annually to this region through the San Felipe Unit of the Central Valley Project. Exported water is delivered both to agricultural and urban users in San Benito and Santa Clara counties. The San Benito River also provides surface water to agriculture in the area. The San Benito River joins with the Pajaro River and flows through the agricultural areas around Watsonville then on to the ocean.

Some of the coastal area around Watsonville is experiencing sea water intrusion as a result of groundwater overdraft. To combat this, a proposed extension of the San Felipe pipeline may bring additional Delta waters to the Watsonville area.

Agricultural acreage in the upslope portions of the Santa Clara Valley and around Watsonville is anticipated to decline slightly in the future as a result of increased urbanization and increasingly high water costs.

Agricultural Information

Types of crops grown:	Truck crops, strawberries, artichokes, fruit trees and vines.
Irrigated Land:	approx. 100,000 acres
Types of irrigation systems in use:	Mostly pressurized systems using drip/micro or sprinklers. Some furrow irrigation still occurs.
Existing average on-farm irrigation efficiencies:	73%, as estimated by DWR
Average applied water:	approx. 200,000 acre-feet annually
Source of Water:	-groundwater is a main source of water for many truck crop fields, except in areas experiencing sea water intrusion. Overdraft conditions exist in some areas of the region.

-imported water delivered from the San Felipe Unit. Other surface water originates in the San Benito River.
-reuse is an important feature in this area. Losses typically recharge groundwater, but in some coastal area, deep percolation is "lost" to degraded groundwater.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses

	Existing Irrecoverable Loss (1,000 af)	Projected Reduction under No Action (1,000 af)	Additional Reduction under CALFED (1,000 af)	Total Reduction (1,000 af)	Remaining Future Irrecoverable Loss (1,000 af)
On-farm	4-6	1-3	1-2	2-5	1-2
District	0-2	0-1	0-1	0-2	0
Total	4-7	1-4	1-3	2-6	1-2

Estimated Applied Water Reduction for Multiple Benefits

Values shown in the table below are estimated reduction in applied water as a result of on-farm efficiency improvements that reduce recoverable losses. These reductions have the ability to benefit flow timing, and the ecosystem, but not water quality. Any return flows that may degrade the quality of the receiving water is not tributary to the Delta.

	Average Existing Applied Water (1,000 af/yr)	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction [1] (1,000 af/yr)
Central Coast	200	4-8	6-12	10-20

1. Totals have been adjusted to exclude any estimated irrecoverable losses presented previously. These estimated reductions do not create an increased water supply, only ecosystem benefits.

AG8 - South Coast

Overview

The South Coast Region lies south of the Tehachapi Mountains and extends to the California border with Mexico. It is home for more than 50 percent of the state's population but only 7 percent of the state's total land area. Rivers and streams that originate in this region flow toward the Pacific Ocean. The climate is Mediterranean-like, with warm and dry summers followed by mild and wet winters. Of the region's 11,000 square-mile area, only around 300,000 acres are currently used for irrigated agriculture. The agricultural net water demand accounts for only about 15 percent of total net water demand in the region. It is projected that the region will increase from a 1990 population of 16 million to over 25 million by 2020. Urbanization of agricultural land is expected to be most pronounced in this region. It is projected that by year 2020 irrigated crop acreage will decline to about 184,000 acres, a 42 percent reduction (DWR, 1994a). Some areas within the region may experience even greater reduction with more than 2/3 of the irrigated land going out of production. Reductions in irrigated land, coupled with existing high levels of efficiency and only marginal irrecoverable losses, will result in little water savings potential through increased efficiency. These factors are reflected in the projections below.

Agricultural Information

Types of crops grown:	Primarily citrus, olives, and avocados (over 50% of the irrigated land). Vineyards, nursery products, and row crops, make up another 40%.
Irrigated Land:	approx. 300,000 acres
Types of irrigation systems in use:	Pressurized systems such as sprinklers, micro-sprays, and drip are widely used for the permanent tree and vine crops. Water delivery systems are mainly pipeline, and in some cases, extensions of municipal systems.
Existing average on-farm irrigation efficiencies:	76%, as estimated by DWR
Average applied water:	approx. 700,000 acre-feet annually
Source of Water:	-groundwater; supplying about a third of the total demand.

-imported water delivered from the Colorado River and from the SWP; limited local surface supplies are also available.
-reuse; the region is greatly increasing its recycling programs, some of which look to deliver treated urban wastewater to agricultural areas.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses

	Existing Irrecoverable Loss (1,000 af)	Projected Reduction under No Action * (1,000 af)	Additional Reduction under CALFED (1,000 af)	Total Reduction (1,000 af)	Remaining Future Irrecoverable Loss (1,000 af)
On-farm	6-7	1-2	1-2	2-4	3-4
District	1-2	0-1	0	0-1	0-1
Total	7-9	1-3	1-2	2-5	4-5

* Note: projected reductions account for loss of over 40% of agricultural land to urbanization based on DWR data (DWR, 1994a).

Estimated Applied Water Reduction for Multiple Benefits

Values shown in the table below are estimated reduction in applied water as a result of on-farm efficiency improvements that reduce recoverable losses. These reductions have the ability to benefit flow timing, and the ecosystem, but not water quality. Any return flows that may degrade the quality of the receiving water is not tributary to the Delta.

	Average Existing Applied Water (1,000 af/yr)	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction [1] (1,000 af/yr)
South Coast	700	20-30	30-50	50-80

1. Totals have been adjusted to exclude any estimated irrecoverable losses presented previously. These estimated reductions do not create an increased water supply, only ecosystem benefits.

AG9 - Colorado River

Overview

The Colorado Region includes a large area of the State's southeastern corner with about 650,000 acres of irrigated land. It mainly includes the agriculturally rich Coachella and Imperial Valleys. The Salton Sea, located between the two valleys, is a prominent feature of this area. The Sea is currently fed by rainfall from the surrounding desert mountains and by agricultural surface drainage from the two valleys. Rainfall in the mountains also recharges the groundwater aquifers that underlie the region. Because of constant evaporation coupled with the rainfall runoff and agricultural drainage, which contain naturally occurring salts, the salinity of the Salton Sea continues to increase. It is now more saline than the Pacific Ocean. However, agricultural drainage is also considered to play a vital role in supplying relatively fresh water supplies to the sea to maintain water levels and dilute salinity and other toxicities that flow to the sea. By year 2020, an estimated 10,000 acre-feet of water will be needed annually to maintain a stable water level in the Salton Sea. Efforts to reduce the agricultural losses that flow to the Sea must consider this fact. Several plans to conserve water in the area while stabilizing the sea's salinity and water levels have been developed by the Salton Sea Task Force, chaired by the State Resources Agency. However, these plans would incur substantial cost (DWR, 1994a).

Agricultural Information

Types of crops grown:	Row crops such as cotton, grain, sugar beets ,corn alfalfa, other truck crops. Alfalfa constitutes about 34 percent of irrigated acreage. About 7 percent of irrigated land (50,000 acres) is vineyard and citrus. Double cropping also occurs.
Irrigated Land:	approx. 650,000 acres with 100,000 acres additional resulting from double cropping
Types of irrigation systems in use:	Majority of the area is under surface irrigation (e.g., furrow). Sprinkler and drip/micro systems are more prevalent on trees and vines.
Existing average on-farm irrigation efficiencies:	76%, as estimated by DWR
Average applied water:	approx. 3,600,000 acre-feet annually

Source of Water: -groundwater, including an overdraft of approx. 75,000 acre-feet annually (although not all attributable to agriculture - the resort areas in Coachella Valley also use a significant amount of groundwater resources)
-surface water is delivered from the Colorado River via the All American Canal. A small amount of SWP water is also delivered to Coachella Valley via an exchange agreement that exchanges Colorado River water for Delta export water.
-reuse of losses is an important feature and is increasing through the adoption of on-farm tailwater recovery systems and district-wide improvements, especially in the Imperial Valley. Most of the Imperial Valley is underlaid with tile drains that collect deep percolation and route the "excess" to surface drains where it co-mingles with surface runoff.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses

	Existing Irrecoverable Loss (1,000 af)	Projected Reduction under No Action (1,000 af)	Additional Reduction under CALFED (1,000 af)	Total Reduction (1,000 af)	Remaining Future Irrecoverable Loss (1,000 af)
On-farm	160-185	40-60	30-50	70-110	75-90
District	200-225	125-150	35-55	160-205	20-40
Total	360-410	165-210	65-105	230-315	95-130

Special Conditions:

The Imperial Valley and most of the Coachella Valley may have a limited role to play in a CALFED Bay-Delta solution. Since water used in this area is primarily imported from the Colorado River, reduction in losses will not directly affect the Bay-Delta watershed. However, the potential exists to use real water savings to offset existing or future demands of southern California, a primary exporter of Bay-Delta waters. To the extent that this can occur, a benefit may be realized in the Bay-Delta watershed. If conserved water is used by southern California, but not in a manner to reduce existing or future Bay-Delta exports, then no benefit can be claimed by the CALFED Program. This is the most probable outcome, since California already diverts more than its allocation of Colorado River water entitlement.

Efforts by other states with entitlement to Colorado River water, including Arizona, Colorado, and Utah, may soon force California to reduce its total diversion from the Colorado. Today, agriculture uses about 3.8 million acre-feet annually of Colorado River. Urban uses, delivered to southern California via the Colorado Aqueduct, account for an additional 1.3 million acre-feet. California's entitlement, though, is only 4.4 million acre-feet annually, approximately 800,000 acre-feet less than existing diversions. The urban demands of southern California met by the Colorado River, delivered via the Colorado Aqueduct, would most likely remain at the levels seen today, or 1.3 million acre-feet. Therefore, reduction would probably occur through reducing agriculture's use of California's entitlement in order to reach the 4.4 million acre-foot limitation.

This has started to occur already with near completion of the Metropolitan Water District's transfer agreement with Imperial Irrigation District. This landmark agreement will result in just over 100,000 acre-feet annually being transferred from agricultural uses in the Imperial Valley to urban uses in southern California. The water is generated through conservation and efficiency improvements. The transferred quantity will be conveyed via the existing Colorado Aqueduct which already runs at capacity. In essence, this is a method of reducing California's overall use of Colorado River water to its required entitlement but maintaining full use of the Colorado Aqueduct to deliver water to urban areas.

Recently, new conveyance facilities from the Imperial Valley to the San Diego area have been proposed as part of another agricultural to urban water transfer. Political pressure from the other Colorado River states with entitlement may limit the potential for such new facilities. Limiting conveyance capacity to that available in existing facilities can provide some assurance to other states that California will reduce its use of Colorado River water down to its required entitlement. New conveyance facilities could be perceived as allowing continuation of diversion above entitled quantities.

The estimated real water savings potential shown above includes the potential of 200,000 acre-feet that may be transferred to the San Diego area under the proposed water transfer agreement. In addition, effects of the Imperial Irrigation District/Metropolitan Water District water transfer have already been accounted for in the No Action estimates. For example, previous estimates by DWR of the real water savings potential were 273,000 acre-feet (DWR, 1994), nearly 100,000 acre-feet higher than the potential shown under No Action. This assumes that the transfer is part of the existing conditions.

Estimated Applied Water Reduction for Multiple Benefits

Because the source of water used in this region originates in the Colorado River and not the Sacramento-San Joaquin River Delta, the ability for applied water reductions to generate water quality, timing, or ecosystem benefits in the Delta do not exist. Therefore, no estimates of applied water reduction were developed for this region.

Summary of Estimated Agricultural Real Water Savings

The following is a summary table presenting the total estimated reduction in irrecoverable losses for the agricultural zones discussed above. It is assumed that water associated with these reductions could be reallocated to other beneficial water supply uses. However, the values shown are only for purposes of programmatic impact analysis and not goals or targets of the component.

Table 4.1 - Estimated Real Water Savings

	Existing Irrecoverable Loss (1,000 af)	Projected Reduction under No Action (1,000 af)	Additional Reduction under CALFED (1,000 af)	Total Reduction (1,000 af)	Remaining Future Irrecoverable Loss (1,000 af)
Sacramento	0	0	0	0	0
Delta	0	0	0	0	0
West SJR	50-65	8-15	30-45	40-60	5-15
East SJR	5-8	1-4	1-3	2-7	1-3
Tulare	95-115	20-30	25-35	45-65	45-50
San Francisco	0	0	0	0	0
Central Coast	4-7	1-4	1-3	2-6	1-2
South Coast	7-9	1-3	1-2	2-5	4-5
Colorado	360-410	165-210	65-105	230-315	95-130
Total	520-615	195-265	125-195	320-460	155-200

Although the total potential reduction associated with irrecoverable losses could amount to 400,000 acre-feet, it must be recognized that this assumes all agricultural water users will achieve the 85 percent level of efficiency and distribution uniformity will increase to between 80 and 90 percent, an attainable situation. But, to achieve this will require significant local and agency resources.

It should also be noted that the additional potential generated by a CALFED water use efficiency program is less than half of the total shown (e.g., only about 150,000 acre-feet of nearly 400,000). This assumes that existing trends will continue to provide improved efficiency regardless of the outcome of the CALFED Bay-Delta Program. In addition, about half of the CALFED increment is from the Colorado Region, which may or may not provide any Bay-Delta benefit.

Summary of Estimated Agricultural Applied Water Reduction for Multiple Benefits

The following is a summary table presenting the total estimated reduction in applied water losses for the agricultural zones discussed above. It is assumed that water associated with these reductions can not be reallocated to other water supply uses. The savings, though, can have water quality, timing, and ecosystem benefits. Values shown are only for purposes of programmatic impact analysis and not goals or targets of the component.

Table 4.2 - Estimated Applied Water Reductions at 85% On-farm Irrigation Efficiency

	Average Existing Applied Water (1,000 af/yr)	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction * (1,000 af/yr)
Sacramento	6,500	200-310	320-470	520-780
Delta	1,300	40-60	60-90	100-150
West SJR	1,400	25-45	40-70	65-115
East SJR	4,000	125-190	190-285	315-475
Tulare	9,300	300-400	400-600	700-1,000
San Francisco	90	3-4	4-6	7-10
Central Coast	200	4-8	6-12	10-20
South Coast	700	20-30	30-50	50-80
	Total	700-1,000	900-1,600	1,600-2,600

* Note: Totals have been adjusted to exclude any estimated irrecoverable losses presented previously. These estimated reductions do not create an increased water supply, only water quality and ecosystem benefits.

The total potential for applied water reduction, including what is projected under the No Action condition, is approximately 2 million acre-feet annually. The CALFED water use efficiency component will help generate about half of this reduction. These reductions can only provide benefits to water quality, flow timing, and to the ecosystem. Though any benefits that can be derived are desirable, they may be minor and will require analysis to determine their cost-effectiveness.

Reductions do not provide a reallocable water supply benefit. Values also assume achievement of 85 percent efficiency by all local users and water suppliers, requiring significant support from local, state and federal agencies.

Estimated Cost of Efficiency Improvements

Reducing recoverable and irrecoverable losses through improved efficiency will result in additional district operation costs as well as on-farm production costs. These increases originate from irrigation system upgrades, changes in management style, and increased operation and maintenance. Cost increases occur regardless of who pays or who benefits. Estimated costs presented in this document do not attempt to allocate the costs or to determine if implementation is cost-effective. Determination of the cost-effectiveness of various efficiency measures will not be estimated for purposes of the programmatic EIR/EIS, but will occur on a case-by-case basis during implementation phases.

Cost of Reducing Applied Water vs. Cost of Real Water Savings

Implementation of specific water delivery improvements, whether on-farm or at the district level, will cost relatively the same whether in the Sacramento Valley or around Bakersfield. This is because the cost of irrigation system hardware, skilled irrigation labor, or higher levels of management does not vary significantly throughout the state. What does vary is the associated reduction in losses. The percentage of applied water that results in recoverable and irrecoverable losses depends on the types of crops grown in a region, on-farm irrigation management, district water supply management and operation, the hydrologic conditions, the soils, and other physical and economic factors.

The cost to reduce applied water losses, regardless of whether recoverable or irrecoverable, can be described in terms of dollars per acre-foot per year. This value would include the capital cost of any system improvements, amortized over the life of the system, and increased costs of operation, maintenance, and management of the system, divided by the potential water savings (in acre-feet annually) that are anticipated to result from implementing the improvements. This value represents the cost to reduce total losses (irrecoverable and recoverable). The cost associated with real water savings (reduction in irrecoverable losses) will be at least as great as that for applied water reduction and in many cases, much greater, for reasons explained below.

In areas where irrecoverable losses have been identified, each acre-foot of applied water loss includes both recoverable and irrecoverable loss. The irrecoverable portion is generally a small percentage of the total, but in some cases it can approach 100 percent. The percentage will depend on the specific local conditions. Irrecoverable loss can be the result of either on-farm or district inefficiencies.

To illustrate this relationship, suppose a field is being irrigated at 75 percent efficiency, defined as the ET of applied water and water needed to maintain salt balance and other cultural practices, divided by applied water. Then 25 percent of applied water goes to losses. If losses (e.g., surface runoff and percolation to degraded groundwater) are split evenly between recoverable and irrecoverable and efficiency improvements equally reduce recoverable and irrecoverable losses, then a reduction by 1 acre-foot of applied water reduces irrecoverable loss by half that amount. Therefore, efficiency improvements that may cost $50 per acre-foot of applied water reduction actually cost $100 per acre-foot of real water savings (reduced irrecoverable loss).

Similarly, if irrecoverable loss accounts for only 20 percent of applied water savings, the actual (real) cost per acre-foot of real water savings would be five times greater, or $250 per acre-foot. The same example could also be made to describe this concept as it applies to district inefficiencies. However, in such an example, the field may be replaced with a set of delivery canals. Either way, some fraction of each acre-foot of loss is irrecoverable, but not necessarily the entire acre-foot.

The analysis below uses a range of irrecoverable loss from 10 percent to 50 percent of total loss, based on estimates of existing on-farm conditions developed by the Bureau of Reclamation (DOI, 1995). This translates to cost increases of 2 to 10 times the cost for applied water reduction.

Estimated On-farm Efficiency Improvement Costs

Cost estimates to increase on-farm irrigation efficiency are based on a study prepared for the Bureau of Reclamation "On-Farm Irrigation System Management", (Young, et al., 1994). This study estimates the costs and performance characteristics of many different irrigation systems for eight crop categories common in the Central Valley. Costs are based on different combinations of hardware, operational regimes, and management, and are expressed as dollars per acre per season. For a given crop, each irrigation system option is summarized by two main characteristics: the irrigation efficiency, and the cost per acre per season.

For each crop, a nonlinear curve was fitted using each cost versus efficiency combination as a data point. The fitted curves describe the trade-offs between cost and irrigation efficiency. These curves have been incorporated into a regional agricultural production model called the Central Valley Production Model (CVPM). CVPM also incorporates data on cropping patterns, water use, and costs by region.

Using CVPM, estimates were made of the cost to improve average on-farm irrigation efficiency from current, or baseline, levels to 80 percent, then again to 85 percent. The model increases efficiency by 1 percent increments until the desired level is reached. The cost shown represents the cumulative cost to move from a baseline efficiency to the 85 percent level.

The values are presented on a per acre-foot per year basis for regions in the Central Valley. Values for areas outside the Central Valley were extrapolated from the Central Valley data since the model is limited to the Central Valley.

Table 4.3 - Range of Annual Costs to Achieve On-Farm Irrigation Efficiency of 85%

	Cost per Acre-foot of Applied Water Reduced ($/acre-foot/year)	Irrecoverable Loss Identified (see Table 4.1)	Cost per Acre-foot of Irrecoverable Loss Saved[1] ($/acre-foot/year)
Sacramento	50-60	none ident.	--
Delta	40-50	none ident.	--
West SJR	35-45	yes	80-400
East SJR	55-70	minimal	--
Tulare	75-95	yes	170-850
San Francisco	75-95[2]	none ident.	--
Central Coast	75-95 [2]	yes	170-850 [2]
South Coast	75-95 [2]	yes	170-850 [2]
Colorado	-- [3]	yes	170-850 [2]

Note: Each cost presented is the annual cost to move from a baseline efficiency to 85%.

1. Cost shown for reducing irrecoverable losses are based on assuming 10 to 50% of each acre-foot of applied water reduction is irrecoverable (i.e., costs are multiplied between 2 and 10 times the cost of applied water savings).
2. These values have been extrapolated from the Tulare region results.
3. Colorado region has no water quality or ecosystem benefits that can be translated to the Bay-Delta.

The cost shown above represents the cost incurred for implementing and maintaining improved efficiency measures. However in some cases, as a benefit of improved irrigation efficiency, a small discount may be subtracted from the values as a result of less water applied to the field (i.e, less water is purchased or pumped). This is just one of the potential economic benefits that may offset the cost of implementing improved irrigation, but not the only. As discussed in the following two paragraphs, the cost can decrease or increase, depending on the situation.

Because water supply costs vary for each region, a beneficial savings that may be experienced from reducing applied water will also vary. Cost reductions will also depend on which supply of water is reduced, surface water or groundwater. If surface supplies are reduced, generally considered less expensive than groundwater, then the savings benefit is lower. If groundwater pumping is reduced, the cost savings are usually greater. In general, reduced surface supply costs can offset the efficiency costs shown above by $2-$10 per acre-foot per year. Assuming a mix of reduced groundwater and surface supplies, this offset can be up to $10-$30, with the higher dollar savings occurring in areas with already higher per acre-foot costs (e.g., Tulare). These estimates assume that water supplies' fixed costs are held constant.

Though most water users will gain a minor savings from reduced water supply costs, some will see a minor increase. Increases will most likely be experienced by water users who currently are dependent on the losses of others to supply their needs. As these losses are reduced, so is their indirect water supply. To offset this, these users will have to obtain water directly, either through groundwater pumping or direct delivery from a water supplier. In either case, the cost to obtain direct delivery of water is usually greater than the cost of indirect use.

Estimated District Efficiency Improvement Costs

In addition to on-farm efficiency improvement costs to the growers as depicted on Table 4.3, there will be costs for on-farm improvements that districts or other local agencies may incur associated with necessary district or agency level improvements. Without support by the water suppliers and other water agencies such as DWR and the U.S. Bureau of Reclamation, high on-farm efficiency, if not impossible, can be much more difficult to achieve. In addition, districts will have significant costs for district level improvements such as lining canals, flexible water delivery systems, regulatory reservoirs, tail-water and spill-water recovery systems, etc. Estimates/projections of these costs for such improvements for different regions were made using information from local agencies, the Department of Water Resources, and data from the U.S. Bureau of Reclamation. Because of the unique situation at each water district, it is difficult to generalize about the costs. However, estimates are presented here for purposes of aiding in the programmatic impact analysis. Costs shown for each region may vary greatly for each specific project.

Table 4.4 - Estimated District Efficiency Improvement Costs ($/year)

	Cost to Support On-Farm Efficiency Improvements[1]	Cost For Improvements in District Water Delivery[2]	Total Cost to the Districts	Average Cost per Acre ($/ac/yr)[4]
Sacramento	9,000,000	4,250,000	13,250,000	7.80
Delta	1,000,000	1,250,000	2,250,000	4.50
West SJR	4,000,000	1,080,000	5,080,000	11.80
East SJR	6,000,000	3,180,000	9,180,000	7.25
Tulare	13,000,000	8,000,000	21,000,000	6.60
San Francisco	300,000	150,000	450,000	7.50
Central Coast	1,000,000	250,000	1,250,000	12.50
South Coast	1,000,000	none[3]	1,000,000	3.30
Colorado	3,000,000	1,630,000	4,630,000	7.10

1. This may include more district personnel, increased operation and maintenance costs, use of CIMIS stations, hiring irrigation advisers, etc. The cost will vary regionally because of the different crops and irrigation system mixes that are inherent in each region.
2. Estimates are based on a $2.50 per acre per year cost for district level activities such as improved delivery system monitoring/measurement, canal lining, system automation, and regional tailwater recovery systems. This cost is assumed to occur every year but may be higher in some years than other.
3. No value is provided for South Coast because most agriculture in this area is already served by pressurized municipal type delivery systems. Additional improvement potential is limited.
4. Average cost per acre is the total district cost divided by the average irrigated acreage in each region (acreage values were presented previously under each zonal description).

5. Urban Water Conservation

This section presents the basis and background for estimating potential water savings and identifies related impacts that may occur as result of the CALFED No Action alternative and as a result of the CALFED Water Use Efficiency Program, or CALFED alternative. The proposed CALFED approach to urban conservation is focused on identifying and implementing new measures, as well as expand existing measures, to improve the efficiency of local urban water use.

This section is intended to be used solely for Phase II impact analysis and is not intended to provide planning recommendations. The following information is included:

- potential reductions in losses resulting from efficiency improvements, either as real water savings, or benefits to water supply reliability, water quality or the ecosystem,
- the cost associated with implementing urban conservation improvements, and
- the potential impacts from efficiency improvements to various resource categories.

Summary of Findings

Improvements in urban water use efficiency can result in reduction of urban per-capita use. A large percentage of these reductions can result in real water savings that can be reallocated to meet other water supply demands. Though not all of the reduction generates real water savings, reduction in per-capita water use can result in benefits to water quality, the ecosystem, and energy needed for water treatment (both potable processes and wastewater) and home water heating. Estimates are separated into two categories:

- estimated real water savings resulting from reduction in urban consumptive use and irrecoverable losses, and
- estimated reduced per-capita use resulting from reduction in recoverable uses. (Only the portion of this category of use reduction shown as 'irrecoverable loss savings' will result in water that can be reallocated to other water supply uses.)

Based on the detailed assumptions and data described in this section, the following estimates of cumulative savings from conservation measures are shown in Figures 5.1 and 5.2.

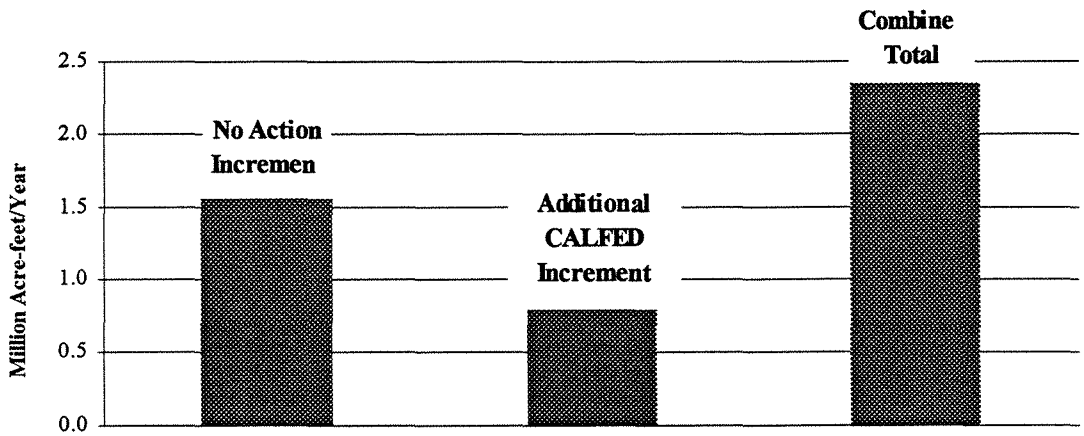


Figure 5.1 - Estimated Statewide Range of Real Water Savings

The incremental portion generated by CALFED is about a third of the total projected savings. This water can be reallocated to other beneficial uses.

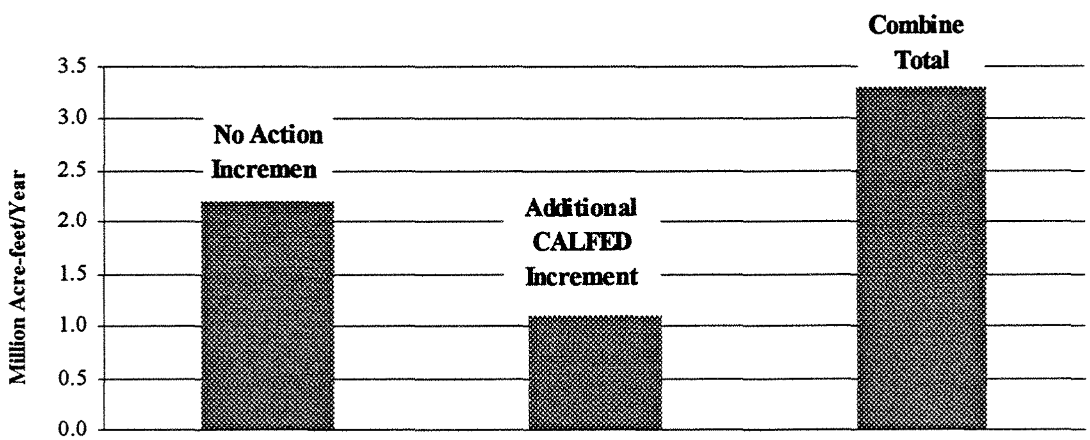


Figure 5.2 - Estimated Statewide Range of Applied Water Reduction

This is the total potential savings. However, only the amount shown in Figure 5.1 is available to reallocate to other uses.

Though the conservation savings shown in these figures are sizable, it must be recognized that to gain such savings requires full implementation of conservation measures by all urban water use sectors. To achieve this will require increased levels of support and commitment from federal, state, and local agencies.

Costs associated with implementing conservation measures to achieve these loss reductions will vary case-by-case. Both customer level and water supplier spending is necessary in order to obtain the anticipated levels of improvement. Generally, customer cost to reduce water use ranges from

$300 to $600 per acre-foot annually. Water supplier costs can add an $2 to $9 per person per year to the cost of conservation. This is for conservation support programs, including completing plans, developing customer programs and education. A small portion of this per-capita increment accounts for water supplier distribution system leak reduction programs.

The cost for real water savings, in contrast to reducing applied water, is greater because in many cases, only a fraction of the applied water reduction will yield real water savings (see Figure 5.3). Where real water savings do occur (mostly in the coastal regions of the state), the cost of real water savings is estimated to range from $400 to $1,600 per acre-foot per year. A detailed discussion of conservation cost is provided toward the end of this section.

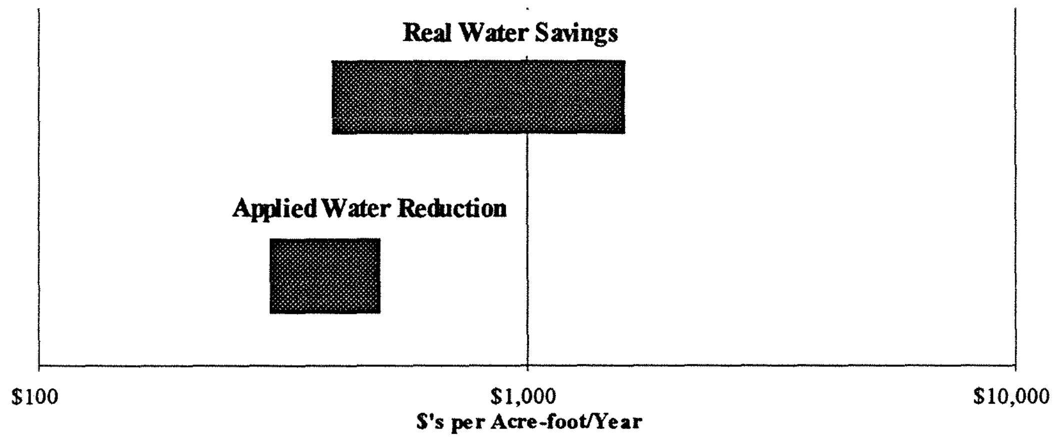


Figure 5.3 - Estimated Range of Cost to Improve Urban Water Conservation
Generating real water savings can cost more than reducing applied water depending on the fraction of real water savings generated by each acre-foot of applied water reduction. The lower real water costs occur in the coastal regions, where the majority of savings also occur.

Section Overview

The remainder of this section provides a more detailed discussion on the basis used to estimate the potential reduction in per-capita water use. The section is subdivided into the following topics:

- General state-wide assumptions
- Specific state-wide assumptions - including the basis for projecting indoor residential, urban landscape, commercial, industrial, institutional, and system distribution loss savings for the CALFED No Action alternative as well as those anticipated for the CALFED solution alternative.
- Real water savings versus applied water reduction - including differentiation of the two types of losses and the benefits that can be derived from each.
- Regional reduction estimates - including descriptions and assumptions for each urban zone and the resulting projection of reduced indoor water use, landscape water savings, and distribution system loss reductions.
- Estimated cost of conservation measures - including cost information for each urban zone associated with implementing conservation measures.
- Anticipated impacts, beneficial and adverse, resulting from conservation measures.

General State-wide Assumptions

Information presented in this section is for the sole purpose of identifying potential impacts, both beneficial and adverse, as part of the CALFED Bay-Delta Program Programmatic EIR/EIS. Neither the information nor the analysis is intended to be used for planning recommendations. Impacts associated with anticipated actions will be described in more general terms than may be presented in a site specific EIR. Therefore, information developed here, as a first step in impact analysis, is based on broad assumptions. The general state-wide assumptions listed below guided the development of necessary information used during the analysis of impacts. Specific assumptions are described for each urban zone later in this section.

- It is assumed that any decrease from existing levels of water use will be first used to offset portions of future demands resulting from increasing urban populations. Increased water conservation in the urban sector is assumed to improve the reliability of water supplies for the local entities implementing the measures. Urban water conservation is not anticipated to result in dramatic decreases in existing levels of gross demand. However, it is assumed to result in future demands being less than otherwise may have occurred.

- Urban populations are expected to increase from approximately 32.7 million to 49 million by 2020. This estimate is based on Department of Finance projections and is used by the Department of Water Resources for water demand projections. State policy requires that all state agencies use Department of Finance population data for planning, funding, and policy-making activities.

- Conservation of water that results in additional water supply is limited to the reduction of urban consumptive use and irrecoverable losses. These include reductions in landscape consumption and industrial, commercial, and institutional consumption, as well as reduction of losses to evaporation, saline sinks, including ocean discharge, and poor-quality perched groundwater. More detailed discussion of this is included later.

- Conservation of water in areas where water returns to the hydrologic system in a usable form can potentially be credited with ecosystem, water quality, or energy savings benefits but typically not water supply benefits. This primarily relates to daily per-capita demand that generates wastewater which, after treatment, is returned to a useable body of water. Existing beneficiaries that may be adversely impacted when changes are made need to be taken into consideration when implementing conservation measures. These include wastewater discharges that contribute to historic instream flows or groundwater recharge, and downstream users of treated wastewater. For example, indoor residential conservation measure to reduce diversions may adversely impact historic wastewater discharges that benefit instream flows in a specific waterway.

- Water that is conserved is assumed to remain in the control of the supplier for its discretionary use or reallocation. This could include using the conserved water to meet local growing urban demands, offsetting groundwater overdraft or saline intrusion, or transferring to another benefactor, including the environment. It cannot be assumed that conserved water is automatically available for environmental uses.

- Water savings experienced by export areas importing water sources in addition to Delta water will not necessarily result in the reduction of Delta exports. How water savings are reallocated is a local decision based on local economic and water supply conditions. For example, assume a water agency could save 100,000 acre-feet of water annually by conservation measure *X*. This savings could reduce demands for Delta water (future or existing), or it could reduce demands from another source, such as the Colorado River, or offset the need for other new sources. As a result of this unknown, conservation savings should <u>not</u> be assumed to result in a direct reduction of Delta exports.

- It is not the intention of this effort to reanalyze estimates of water use efficiency improvements that have recently been developed by others. This effort has directly included or has used information developed or presented by the following:

  -Department of Water Resources (DWR). 1994a. "California Water Plan Update." Final Bulletin 160-93.
  -Department of Water Resources (DWR) - internal staff work developed as

background and draft input data for Bulletin 160-98.
-U.S. Department of Interior (DOI) - Bureau of Reclamation, Mid-Pacific Region and Fish and Wildlife Service. September 1995. "Demand Management - Technical Appendix #3 to the Least-Cost CVP Yield Increase Plan."
-Pacific Institute. May 1995. "California Water 2020 - A Sustainable Vision."

Specific State-wide Assumptions

The assumptions listed here provide the specific basis for estimating conservation potential from implementation of efficiency measures. Estimates are based on determinations of:

- existing conditions,
- the CALFED No Action alternative which includes conditions expected upon implementation of urban BMPS to levels targeted in the existing urban MOU, and
- the CALFED solution alternative which includes projections of future conditions that could exist as a result of the CALFED Water Use Efficiency Common Program.

Technical assumptions presented below are categorized into the following:

- urban per-capita water use
- residential indoor conservation
  - existing residential indoor use
  - projected conservation under the No Action Alternative
  - additional conservation as a result of the CALFED Program
- urban landscape conservation
  - existing use
  - projected conservation under the No Action Alternative
  - additional conservation as a result of the CALFED Program
- commercial, industrial, and institutional conservation
  - existing use
  - projected conservation under the No Action Alternative
  - additional conservation as a result of the CALFED Program
- water delivery system loss and leakage reduction
  - existing system losses
  - projected reduction in losses under the No Action Alternative
  - additional reduction in losses as a result of the CALFED Program

Urban Per-Capita Water Use

Since the 1976-77 drought, a combination of mandatory requirements and voluntary agreements have directed municipal government and urban water suppliers to implement water conservation practices. Current urban water conservation programs reflect state and federal legislation that mandated changes designed to improve the efficiency of plumbing fixtures, and a voluntary MOU that set the industry standard for conservation programs.

The Urban MOU

One of the primary forces behind increased urban conservation in the recent past has been the adoption of the *Memorandum of Understanding Regarding Urban Water Conservation in California* (MOU) by many urban agencies. The MOU, originally drafted in 1991, has over 200 signatories, including over 150 urban water suppliers. The MOU contains 14 BMPS that are to be implemented by each urban water agency, if deemed locally cost-effective and technically feasible. These are listed in Table 5.1. Implementation rates of BMPS by the urban agencies have been behind that scheduled in the MOU. Continuing efforts and a recent renewed focus on BMPS, however, are anticipated to result in increased levels of implementation by the signatory agencies.

Table 5.1 - Recently Revised Best Management Practices in the Urban MOU (Revised Sept. 1997)

1. Water Survey Programs for Single-Family Residential and Multi-Family Residential Customers
2. Residential Plumbing Retrofit
3. System Water Audits, Leak Detection and Repair
4. Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections
5. Large Landscape Conservation Programs and Incentives
6. High-efficiency Washing Machine Rebate Program (new)
7. Public Information Programs
8. School Education Programs
9. Conservation Programs for Commercial, Industrial, and Institutional Accounts
10. Wholesale Agency Assistance Programs (new)
11. Conservation Pricing
12. Conservation Coordinator (formerly BMP 14)
13. Water Waste Prohibition
14. Residential Ultra Low-Flush Toilet Replacement Program (formerly BMP 16)

The California Urban Water Conservation Council, formally established under the MOU, is composed of water suppliers and public interests. The Council updates the list of BMPS, revises implementation requirements and has the role of disseminating information on BMPS among member agencies and reporting to the State Water Resources Control Board on the implementation by signatory agencies of BMPS listed in the MOU. CALFED has proposed that the Council certify water supplier compliance with terms of the MOU.

Per-Capita Water Use

Urban water demand is often described in terms of *per-capita water use*. Most often, this term represents average daily water use in gallons per person per day. However, the daily use is an aggregate figure and actually represents the combination of several water using sectors, divided by the population of the region. These sectors include:

- residential,
- commercial, industrial, institutional, and
- other, which includes fire flows, median landscapes and other miscellaneous uses.

For example, a per-capita demand of 200 gallons per-capita per day (gpcd) may represent a community's total residential, commercial, industrial, institutional, and other uses, including fire fighting and distribution losses, divided by the area's population. Yet, the residential portion may only be 60 percent of the total (or 120 gpcd), with the remainder used by local commercial and industrial businesses, and others. Gross per-capita rates in some regions of the state reflect large industrial or commercial enterprises combined with low resident populations. For example, as shown in Table 5-2, the Colorado River region has high per-capita water use rates because of tourist populations and a predominance of golf courses. The combination of the various water use sectors will vary from community to community and region to region and can also vary diurnally, weekly, monthly, and seasonally.

Generally, the per-capita water use is used to characterize and understand the overall water demands for an area, to help plan for additional demands, and to look for opportunities to reduce demand. The Department of Water Resources has estimated per-capita demand through use of census data, models, local information, and an array of other investigations. DWR has noted that, in the long-term, permanent water conservation programs and other factors have begun to reduce overall per-capita water use in some areas. However, other factors tend to raise per-capita rates, thus making it difficult to analyze trends. Future per-capita use rates are estimated from current rates but are further influenced by on-going conservation efforts and anticipated increases in regional economics. The latter factor can increase residential water use and landscaping demand because of inherent lifestyle changes that accompany increases in income. DWR projects that conservation measures will reduce current per-capita use rates, though economic effects will tend to offset some conservation gains. Table 5-2 shows DWR's estimates of future per-capita water use:

Table 5.2 - Current and Projected Regional Urban Per-Capita Water Use (gpcd)

Urban Zone	1995 Estimates [1]	2020 Projections [1]
UR1 - Sacramento River	274	257
UR2 - E. San Joaquin River	301	269
UR3 - Tulare Lake	311	274
UR4 - San Francisco Bay	177	169
UR5 - Central Coast	180	164
UR6 - South Coast	208	186
UR7 - Colorado Region	578	522
Statewide Average	224	203

1. Values are based on DWR data as of spring 1997.

The values shown for 2020 have been estimated by DWR independent of the CALFED program and are based on full implementation of the BMPS currently included in the urban MOU. DWR assumes that, although the actual implementation of urban BMPS is behind schedule, they are to be fully implemented by 2020 (original implementation was to occur by 2001). This level of BMP implementation is anticipated by DWR to conserve an estimated 1 million acre-feet of real water savings annually statewide by the year 2020. This real water savings is an aggregate of conservation occurring in the residential, commercial, industrial, institutional, and other water use sectors and is based on assumed reductions factors for quantifiable BMPS only.

It is assumed for purposes of the CALFED Program that the values projected for 2020 represent the combined effect of conservation in the future without a CALFED solution, or No Action alternative. Similar to the assumptions in the agricultural section, the CALFED Program's water use efficiency component is envisioned to go beyond this level and gain further implementation of conservation resulting in further reductions in per-capita water use. These gains are anticipated to primarily result from further residential indoor and urban landscape conservation. The following subsections provide the breakdown of the estimated 1 million acre-feet of real water savings assumed for the No Action alternative as well as provide estimates of additional savings from the CALFED alternative:

- residential indoor use
- urban landscape use
- commercial, industrial, and institutional use
- water delivery system loss and leakage

Residential Indoor Conservation

Residential water use includes both indoor and outdoor demands and is influenced by many factors, including climate, type and density of housing, income level, cost of water, plumbing fixtures and the kinds of water-using appliances. Family size, metering, and water costs also influence household and per-capita water use (Pacific Institute, 1995).

Existing Residential Indoor Water Use

Current average indoor residential water use is estimated to vary from 65 to 85 gallons per-capita per day and is estimated statewide to average 75 gpcd (DWR data). The range results from the dynamic factors mentioned previously, but is relatively similar in any part of the state. This is primarily because typical residential indoor habits, such as showering, laundry, and toilet use, are not influenced greatly by climate or location. Rather, indoor water use is influenced by family income, family size, housing type, and other non-geographical factors. This is in contrast to the wide fluctuation in urban landscape water use as discussed later.

Projected Conservation Under the No Action Alternative

Under the No Action alternative, indoor residential water use is expected to average between 60 and 70 gallons per-capita per day based on installation of new water efficient appliances and plumbing fixtures. Reduced levels of 60-65 are already being achieved in some California communities and are assumed to be achievable statewide.

The highest percentage of indoor use is from toilets, showers, and faucets. Plumbing code changes made in the 1970's and again in the early 1990's have required installation of only low water using fixtures for toilets, showers, and in some areas, other plumbing fixtures. Though these changes are implemented slowly in existing structures as fixtures are replaced, change-out of many plumbing fixtures is anticipated by 2020, regardless of a CALFED solution. New housing will already have the low water use fixtures so further upgrades to them would not be necessary. Furthermore, replacement of existing high water using appliances, such as dishwashers and washing machines, with new, more efficient appliances, will also help reduce the per-capita water use to achieve the anticipated levels.

Additional Conservation as a Result of the CALFED Program

Opportunities exist to further reduce indoor use to as low as 50 to 60 gpcd. This amount is still ample for continuation of existing lifestyle habits, such as daily showers, dishwashers, laundry, and use of water softeners. This additional reduction is obtained through measures such as more aggressive interior water audits, use of incentive programs to ensure installation of remaining low use fixtures in all residences, conversion to low water use shower heads, and gradual conversion to very efficient appliances in the majority of households, such as horizontal axis washing machines (a new technology to the United States but widely used in other parts of the world, such as Europe and the Middle East). Also assumed is development of additional technologies and incentive programs that go beyond BMPS currently suggested in the urban MOU. Lifestyle habits do not have to change to allow these gains to occur. To achieve these levels, though, will require strong incentive programs and public outreach to gain widespread acceptance and implementation.

For purposes of the CALFED Program, indoor residential water use rates are assumed to reach 50 to 60 gpcd statewide. This value will result in applied water savings statewide and real water savings in the populated coastal areas (see discussion later regarding *Real Water Savings versus Applied Water Reductions*). The estimated savings are shown under each zonal description, also provided later in this section.

To estimate the potential additional annual water savings, the change in per-capita use from current to projected is multiplied by the projected population of the region. For example, if a region is generally at 70 gpcd, a change to 60 gpcd would result in a savings of 10 gpcd for the entire population. If the region's population is forecast at 5 million, than the potential annual savings could be 10 gpcd multiplied by 5 million people, or about 50,000 acre-feet annually. Assumptions for each region are presented under the zonal descriptions below.

Urban Landscape Conservation

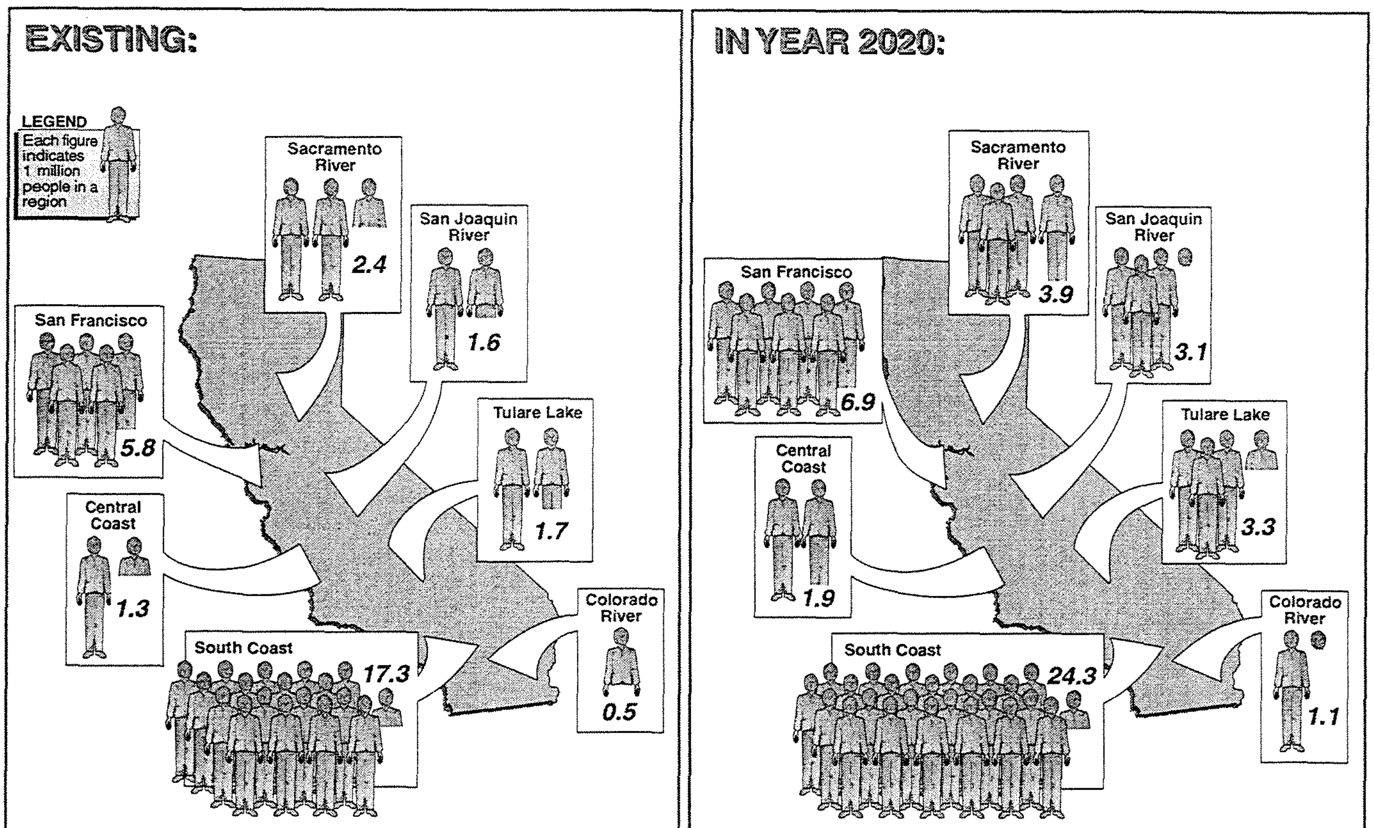
Outdoor water use for landscape irrigation varies widely across California. In fact, this portion of urban water use is probably the most varied of all urban water use factors. In hot, inland areas, average outdoor per-capita use, primarily from landscaping evapotranspiration, can be as high as 60 percent of the total residential use. Conversely, in cooler coastal areas, outdoor use can be as low as 30 percent of total residential use. Effective precipitation occurring in coastal areas, either as rain or dew from fog, also acts to reduce coastal area outdoor use.

Current estimates of statewide urban acreage indicate about 1 million acres of urban areas are part of an irrigated landscape. A large majority occurs in the South Coast region which includes the area from greater Los Angles to San Diego. It is anticipated that as the State's population increases, so will the residential landscape acreage. However, data regarding current acreage amounts and relationships to potential increases are not readily available. For purposes of the CALFED Program, the 1 million acre estimate has been distributed statewide based initially on population. Values were adjusted to account for assumed regional differences such as coastal areas generally having smaller yards and more people per household than inland areas (e.g., San Francisco versus Sacramento), thus less total acreage per person. Estimated current and projected acreage values are shown on Table 5-3. Values for 2020 were projected by increasing current estimates by the ratio of a region's forecasted population to its existing population (population information is presented for each urban zone later in this section). Regional population estimates are displayed in Figure 5-4.

Table 5.3 - Urban Landscaped Area (acres)

	1995 Estimated	2020 Forecast
UR1 - Sacramento River	100,000	145,000
UR2 - E. San Joaquin River	65,000	120,000
UR3 - Tulare Lake	70,000	130,000
UR4 - San Francisco Bay	155,000	180,000
UR5 - Central Coast	35,000	50,000
UR6 - South Coast	480,000	650,000
UR7 - Colorado Region	35,000	75,000
Total	940,000 [1]	1,350,000

1. Values shown in the table do not add to 1 million acres some areas of the state like the north coast and eastern side of the Sierra Mountains are outside the CALFED Program geographic scope.



SOURCE: DWR 1997 Draft Planning Data
137238.ZZ.ZZ Populations 1-8-98abm

Figure 5.4
Regional Population Distribution
Note the continued population density in the South Coast region.

Irrigation Needs of Urban Landscapes

Each acre of urban irrigated landscape represents a demand for water. To determine this demand, one major element in the calculation is the evapotranspiration rate (ET). ET is the amount of water evaporated by the soil (evaporation), and used by the plants (transpiration) over a given period of time. Reference evapotranspiration (ETo) is a measurement of a standard crop (well watered, cool season grass, four to six inches tall), under standard conditions.

ETo is usually determined daily for a specific area using climatological instruments at specific locations. Daily values are cumulated to form average monthly or annual values. Though the specific ETo for every location is not available, average ETo values for most regions of the state are fairly well accepted and used for planning and analysis. The following values are assumed for purposes of the CALFED Program:

Table 5.4 - Reference ETo Values Assumed Urban Regions

	Reference ETo
UR1 - Sacramento River	4.2 (feet/year)
UR2 - East San Joaquin River	4.3
UR3 - Tulare Lake	4.3
UR4 - San Francisco Bay	3.3
UR5 - Central Coast	2.8
UR6 - South Coast	4.0
UR7 - Colorado Region	6.0

Once the ETo is determined for an area, three other factors must be considered: the size of the area to be irrigated, the plants within the area, and the efficiency of the irrigation system. DWR estimates that there are 1 million acres of irrigated landscape in California.

The amount of water a plant needs in relation to the standard measurement of ETo varies depending upon the physiology of the plant. In general, cool season grasses like Kentucky Bluegrass and Fescue, require 80 percent of ETo while warm season grasses like Bermuda grass require 60 percent of ETo. Trees, shrubs, and groundcovers in the moderate water-using category (close to 80 percent of the commonly grown plants in California) require 40 to 60 percent of ETo. Low water-using plants range from 0 to 30 percent of ETo.

Generally, the typical California residential landscape, the majority of the urban landscape acreage, has a lawn, some shrubs or other smaller plants, and a few trees. This tends to be the case whether in the Bay Area or Palm Springs, Bakersfield, or Sacramento. Recent landscaping trends in some areas of the State have included planting water efficient landscapes, or xeriscape, a term given to the use of more low water using plants in combination with more efficient landscape designs and irrigation systems. These landscapes can use far less water than the more lawn intensive landscapes but are slow to be adopted in some areas of the State.

The last factor in determining landscape water needs is the efficiency of the irrigation system and operation. Data developed by DWR's mobile irrigation laboratories shows that the statewide average landscape irrigation system has a distribution uniformity (one measure of irrigation efficiency: how evenly water is distributed over a given area) of about 50 percent. While distribution uniformity is more important in terms of lawns than most other landscape plantings, it is an indication that improvements could certainly be made in this area. Surface runoff, because of poor percolation, high application rates, and sloping surfaces contributes greatly to poor efficiency. Improvements in how water is applied can result in water savings without affecting the landscape water needs.

Thus, to determine landscape water needs, the following formula can be used:

Landscape water needs = ETo X area X plant factor/ irrigation efficiency.

This can be converted to a percentage of ETo, or an ETo factor.

Estimating Landscape Conservation Potential

DWR estimates that, on average, statewide residential landscaping is currently irrigated at 1.2 times ETo. For purposes of the CALFED Program, assumptions have been made that reflect adoption of landscape conservation measures, including changes in irrigation systems and operations, as well as changes in landscape type. This has been done through distribution of each region's acreage among various ETo factors for a baseline condition, the No Action condition, and for the CALFED alternative condition (see Supplement C, attached). To the extent possible, local climate combined with assumed traditional attitudes toward landscaping were considered for each region's acreage distribution. In addition, existing landscaped acreage was distributed differently than the increment of new landscape acreage assumed to be planted by 2020. For example, it is less likely that existing landscapes will be dramatically changed from their current configurations (i.e., what is primarily lawn now will probably stay as lawn). However, new acreage could be initially planted with lower ET in mind, such as planting less lawn area, planting more Mediterranean style landscape, or xeriscape. The resultant distributions vary for each urban zone as shown below under the zonal discussions.

A distinction has been made between reduction of losses through irrigation improvements and reduction in landscape ET using the following criteria:

- Any reduction in ETo factor that is still above 0.8 assumes reduction in losses that were attributable to irrigation (e.g., surface runoff to gutters). ETo values of 0.8 and above do not assume any change in the type of traditional lawn oriented landscapes, whether existing or to be planted.

- Any reduction below 0.8 is assumed to represent a change to or new planting of Mediterranean, xeriscape or other landscaping that has lower ET than traditional lawn landscaping.

For example, a change from 1.2 to an ETo factor of 0.6 would assume that the increment of reduction from 1.2 to 0.8 is associated with reducing the losses associated with inefficient irrigation. The additional change from 0.8 to 0.6 would reflect a reduction in ET of the landscape. Depending on the region, some or all of this reduction would be considered irrecoverable (see discussion of *Real Water Savings Versus Applied Water Reduction* below). For example, if the runoff to the street from inefficient irrigation flowed directly to the Pacific Ocean, than its reduction would be a real water savings. If, however, the runoff flowed back to a river that was a source to a downstream users, the reduction would only constitute a reduction in applied water. In either case, though, the reduction in ET in this example would constitute a real water savings.

Baseline Urban Landscape Water Use

For each region, the landscape acreage is distributed among a range of ETo factors, taking into account local considerations such as climate, historic landscaping trends, and public perception regarding landscaping. For example, the South Coast region assumes that existing acreage is spread between ETo factors of 1.2 down to and including 0.6. This assumes that some landscapes in this region are already planted in a Mediterranean or xeriscape style. Sacramento, on the other hand, is assumed to have all of its acreage at an ETo of 1.2 under existing conditions. The acreage distribution for each zone is presented under the zonal descriptions below.

To allow a comparison between the No Action and CALFED conditions, the same pattern of water use seen on existing acreage was assumed for the future 2020 acreage. This created a baseline condition with which to compare savings from No Action and CALFED conditions. For example, the Sacramento River region is assumed to currently have approximately 100,000 acres of urban landscaping. This is projected to increase to 145,000 acres by 2020. The distribution for the current acreage assumes all 100,000 acres use a factor of 1.2 ETo to estimate landscape water use. The future baseline condition also assumes that the 145,000 acres uses the same distribution. This allows for savings potential under CALFED conditions to be estimated.

Projected Conservation Under the No Action Alternative

No Action conditions assume that some improvements to irrigation is made for the existing landscaped acreage. In addition, a small percentage of existing landscaped area is assumed to be modified to lower water using landscapes. For the new acreage, land that will be developed as population grows and new houses are built, assumes more efficient irrigation systems as well as assuming a larger percentage of lower water using landscape will be planted, when compared to change of existing landscapes. For example, local landscape ordinances could be adopted that would result in more Mediterranean or other landscapes conducive to the local climate to be installed for all new housing, instead of typical lawn intensive landscapes. The distribution of acreage across the various ETo factors is shown for each region below under the zonal discussions.

Additional Conservation as a Result of the CALFED Program

The CALFED Water Use Efficiency Program is assumed to result in even greater changes to landscape irrigation and types than envisioned under the No Action condition. This would occur through technical, planning, and financial support along with a more concerted effort, through urban agency certification, to implement cost-effective conservation measures.

For purposes of estimating potential incremental savings above the No Action condition, a third distribution of acreage among ETo factors was made, both for existing acreage amounts and new acreage that will be planted. These distributions simply shifted more acreage lower on the range of ETo factors compared to No Action. Most of the distributions at this level were based on professional judgement.

It is important to note that the potential savings from landscape conservation measures are being used for estimated potential programmatic level impacts. They should not be used for any planning efforts.

Commercial, Industrial, and Institutional Conservation

Statewide, the commercial, industrial, and institutional sectors, collectively referred to as CII, on average represent a little more than 30 percent of the total per capita daily use. The actual amount of use, though, can vary significantly for each local water supplier, depending on the quantity of commercial and industrial use and demand compared with other sector demands. For example, industry may be the predominant user for a particular water supplier, with little or no residential connections in the area. On the other hand, residential use may make up the majority of a supplier's demands, with very little commercial or industrial uses. The percentages of CII use by sector assumed for purposes of this document are presented under each zonal discussion later in this section.

Commercial customers are generally defined as water users that provide or distribute a product or service, such as hotels, restaurants, office buildings, commercial business, and other places of commerce. Industrial users can vary from low water using industries such as clothing manufacturing to high water use industries such as food processing or the semi-conductor industry. Institutional users include establishments dedicated to public service, such as schools, courts, churches, hospitals, and government facilities.

The demand for water from CII customers includes many of the same needs as residential users; toilets, sinks, laundry facilities and kitchens, but the use is often much greater. CII demand can also come from process water, cooling towers, and large restaurant kitchens, as well as outdoor decorative landscaping. Landscape water use, however, is already accounted for under the previous subsection, *Urban Landscape Conservation*, and is not included here. The CII conservation estimates discussed in this section primarily focus on improving the efficiency of internal CII water use.

Baseline CII Water Use

An estimate of baseline CII water use for each urban zone is needed to allow for an estimate of potential conservation savings that may occur under the No Action and CALFED Program alternatives. To generate this estimate, per capita water use values assumed to occur in the year 2020 as a result of population and economic influences were developed. These values, shown below, were estimated by DWR staff as part of preliminary data for draft Bulletin 160-98. These values do not account for anticipated conservation. They can be considered as potential demands given existing conditions but with future populations.

Table 5.5 - Per-Capita Urban Demands to Determine CII Water Use

	Existing Per-capita Total Urban Demand	2020 Assumed Per-capita Total Urban Demand [1]
UR1 - Sacramento River	274	292
UR2 - E. San Joaquin River	301	306
UR3 - Tulare Lake	311	304
UR4 - San Francisco Bay	177	199
UR5 - Central Coast	180	192
UR6 - South Coast	208	218
UR7 - Colorado Region	578	594

1. This is also DWR's baseline for use in Bulletin 160 series analysis.

Note: Per capita use generally increases when a region's population has more money to spend. This consumption is anticipated to occur if no further conservation measures are implemented beyond those in existence today.

A portion of each region's projected per capita water use value is attributable to CII demand. However, it is not necessarily the same percentage as occurs under existing conditions. For example, the San Francisco region has an existing CII demand of 38 percent of the total per capita use value. In 25 years, though, the value may drop as a result of a shift to more commercial users and fewer high demand industrial users. It could also increase or remain the same.

In general, *industrial* use is anticipated to continue to decline or stabilize as a result of:

- increasing environmental constraints regarding wastewater discharge and recycling practices
- more energy and water efficient industrial processes and equipment
- a national shift away from a manufacturing economy to a service oriented economy
- a shift of some industry to out-of-state areas

However, as the state's population and economy increase, *commercial* water use is expected to increase, though the extent is unknown. For purposes of this document, it is assumed that the percentage of per capita use resulting from commercial activities will increase to a greater extent than industrial use declines. The resulting assumed baseline CII percentage are presented below:

Table 5.6 - Assumed Baseline CII Percentage of Urban Per-Capita Use

	Existing CII Percentage	2020 Assumed CII Baseline Percentage
UR1 - Sacramento River	35	36
UR2 - E. San Joaquin River	24	25
UR3 - Tulare Lake	24	25
UR4 - San Francisco Bay	38	38
UR5 - Central Coast	30	30
UR6 - South Coast	32	32
UR7 - Colorado Region	27	28

Note: Existing percentage values are compiled from data submitted to DWR by many water agencies throughout the State.

Projected Conservation Under the No Action Alternative

CII water use is assumed to be reduced by 10 to 20 percent under the No Action alternative. No Action conservation projections are estimated using the CII percentages developed for the baseline situation, coupled with estimated levels of implementation of commercial and industrial conservation BMPS as well as other industry trends regarding efficient use of water.

For example, the urban MOU includes BMPS 9 and 10 directed at commercial and industrial water conservation. Upon full implementation, BMP 9 has the potential for a 12 percent savings in commercial use and a 15 percent savings in industrial use (as quantified in Exhibit 1 of the *MOU Regarding Urban Water Conservation in California*, as amended March 9, 1994). However, some of this savings includes savings from more efficient landscape water use. As previously stated, landscape conservation is already included in the above subsection, *Urban Landscape Conservation*. DWR's Water Conservation Office has analyzed data from a recent southern California CII conservation study and determined that between 15 and 25 percent of CII water use is for landscaping needs. Therefore, the BMP 9 savings estimates should be reduced to realistically estimate interior CII conservation potential.

Several other factors, besides BMP 9 and 10, are believed to result in more efficient water use by this sector by the year 2020. Some of these include:

- existing trends stated above under baseline conditions
- water and wastewater costs will probably increase faster than the rate of inflation to account for infrastructure replacement and population growth creating an incentive to be

more efficient
- California's industrial and commercial sector will become more efficient with their processes, including water use, to gain or maintain a competitive edge
- existing and new businesses will use more efficient equipment as it becomes available
- continued statewide demand for water will continue to bring greater attention to efficient water use practices and present "pressure" to implement conservation measures

As a result of such factors, it is assumed that, under the No Action conditions, CII water use could be reduce 10 to 20 percent below the baseline value upon implementation of all the CII BMPS. The resulting values for each region are shown under each zonal discussion later in this section.

Estimates for potential water savings are calculated by first calculating the CII demand using the projected per capita use without considering conservation in 2020, the projected population for each region, and the percent of total per capita use attributable to CII demands. This value is assumed to then be reduced by the anticipated No Action savings of 10 to 20 percent. Calculated savings are presented below under the specific zonal discussions. It is important to note that the savings shown is in comparison to what demands could be in the future given no implementation of conservation measures and increased populations.

Additional Conservation as a Result of the CALFED Program

As with other components of urban conservation, the CALFED alternative is assumed to result in CII water use savings that reach beyond those estimated under No Action conditions. It is estimated that this additional savings can be as much as 5 to 10 percent, resulting in a total reduction potential of 15 to 30 percent below baseline conditions.

It is assumed that these gains can be achieved through implementation of several measures, such as:

- enlarging the scope of CII water audits to include warehouses, correctional facilities, military bases, utility systems, and passenger terminals (largely ignored under current audit programs)
- incentive programs to obtain consistent, effective data at the water supplier level so they better understand the water needs of their CII customers
- local programs that offer financial incentives, public recognition, technical information, or water rate adjustments
- development and enforcement of local CII water use efficiency ordinances
- State and federal programs that offer financial and technical assistance directly to the CII users

The calculation to determine the potential water conservation as a result of the CALFED Program is similar to that used to determine the No Action savings. However, the incremental CALFED savings are derived from the already calculated No Action savings. For example, if the San Francisco region had a baseline per capita use of 199 gallons per capita per day (gpcd) and CII demand accounted for 38 percent of the use, the resulting demand is estimated at 76 gpcd. Under No Action conditions, this amount is anticipated to be reduced by 15 percent to 64 gpcd, a savings of 12 gpcd. The CALFED incremental savings could result in another 10 percent reduction, resulting in a per capita need of 58 gpcd (10 percent less than No Action). Estimated savings for each region are presented below under the zonal discussions.

Water Delivery System Loss and Leakage Reduction

Throughout the state, urban retailers deliver water via pressurized pipelines to numerous residential, commercial, industrial, and institutional users. These pipelines are made of ductile iron, metal, concrete, plastic, or a combination of materials, and are of various sizes and in a variety of working conditions. For the most part, urban water supplier maintenance and replacement programs tend to correct the worst conditions, but with many systems placed underground more than 50 years ago, and often during the 1930's and 1940's, many leaks still exist. In some instances, this can result in the loss of significant amounts of potable water, water otherwise available for meeting urban demands.

Leaks, the most common form of system losses, may be caused by several factors including:

- corrosion of pipe materials
- faulty installation
- natural events such as earthquakes and land subsidence
- aging water control structures

Current estimates of average statewide system losses are placed at 10 percent of system deliveries. However, the actual losses can vary significantly between urban suppliers with some as high as 30 percent and others less than 5 percent. It is assumed for purposes of this discussion that reduction much below 5 percent of delivered supplies is cost-prohibitive and technically difficult and therefore becomes the upper limit of conservation potential. For example, with several hundred miles of pressurized pipeline for each utility, maintenance activities will always be on-going, with new leaks arising as old ones are repaired.

Current Funding Programs

For the past two decades, DWR has administered several programs to provide loans to local urban water suppliers for replacement of old, leaky systems. The programs include:

- Proposition 25 - The Clean Water Bond Law of 1984. This program authorized the sale and issuance of $325 million in state bonds. Water conservation loans administered by

DWR comprised $10 million of the total. This money was used to provide low interest loans to aid in the conduct of voluntary, cost-effective capital outlay water conservation programs, including system leak reduction.

- Proposition 44 - The Water Conservation and Water Quality Bond Law of 1986. This program authorized the sale and issuance of $150 million in state bonds. DWR was responsible for administering low-interest loans using about half of this funding. These loans were available for cost-effective capital outlay water conservation programs, including system leak reduction.

- Proposition 82 - The Water Conservation Bond Law of 1988. This program authorized the sale and issuance of $60 million dollars which was available for cost-effective capital outlay water conservation programs, including system leak reduction.

These programs have resulted in substantial improvements in local urban distribution systems and have generated water savings of about 60,000 acre-feet annually.

Projected Conservation Under the No Action Alternative

Additional reductions in distribution system losses will continue to occur regardless of the outcome of the CALFED Program. Through continuation of loan programs, mostly administered by DWR, and increasing focus by local agencies of the destination of their water, system loss reductions are assumed to decrease to only 5 percent of water distributions under the No Action alternative.

Estimates of potential savings from reducing system losses to 5 percent are based on the change from estimated current system distribution losses to 5 percent. Because this is a regionally based presentation of values, estimates of current regional urban "unaccounted" delivered water were used, instead of specific retailer estimates. The current level of "unaccounted" water shown in Table 5.7 has been estimated by DWR and is assumed to mostly represent the distribution system losses. The resulting values for each region are shown under each zonal discussion later in this section.

Estimates for potential reductions and associated savings are calculated by taking the difference in the above percentage and the target of 5 percent, multiplied by the existing urban use for each particular region (existing use is the per-capita use times the population). A future baseline value is not used in this calculation because the addition of new conveyance pipelines to meet growing urban populations is anticipated to need much less maintenance compared to existing facilities, and therefore, would not add appreciably to the existing level of system loss.

Table 5.7 - Estimated Unaccounted Water

	Existing Percentage of Unaccounted Water
UR1 - Sacramento River	9
UR2 - E. San Joaquin River	6
UR3 - Tulare Lake	9
UR4 - San Francisco Bay	8
UR5 - Central Coast	10
UR6 - South Coast	9
UR7 - Colorado Region	14

Note: Existing percentage values are compiled from data submitted to DWR by many water agencies throughout the State.

Additional Conservation as a Result of the CALFED Program

Additional reduction in system losses are not anticipated to occur beyond those presented under the No Action conditions. This assumption is based on the continuation of wear and pipeline breakdown that will occur regardless of the time and effort spent trying to prevent it or to immediately correct it. Part of this inability to have less than 5 percent of delivered water be "unaccountable" is because of limited capability to detect leaks in plastic pipes, the latest pipeline material to be used for urban water distribution systems. Though this material is less likely to corrode, therefore has a longer life, cracks or breaks, which will inevitably occur, are difficult to detect.

Real Water Savings versus Applied Water Reductions

Similar to characteristics of water losses in agriculture, losses associated with urban water use can be characterized as either resulting in irrecoverable or recoverable losses. Refer to the discussion in Section IV, *Irrecoverable vs. Recoverable Losses*, for a more detailed explanation of this issue.

In general, all urban water losses from landscaping, commercial or industrial, and residential uses either directly or via a wastewater treatment plant return to surface or groundwater bodies and may be recoverable. In theory, all losses are recoverable. In practice, however, losses that flow to very deep aquifers or excessively degraded water bodies may not be recoverable because of prohibitively expensive energy requirements (i.e., they become irrecoverable). Determining recoverability varies with location and time as well as other factors (DOI, 1995).

Distinguishing between irrecoverable and recoverable losses is typically based solely on water quality considerations. This assumes that all losses to usable water bodies can be economically recovered. Principal water bodies that are regarded as irrecoverable include saline, perched groundwater underlying irrigated land on the west side of the San Joaquin Valley, the Salton Sea, which receives urban wastewater flows from the Coachella and Imperial Valleys, the San Francisco Bay, and the ocean.

Real water savings can only be achieved by reducing irrecoverable losses because they are truly lost from the system. Water is considered "saved" when these losses are reduced. Recoverable losses, on the other hand, often constitute a supply to the downstream user.

Downstream uses can include groundwater recharge, agricultural and urban water use, and environmental uses, including wetlands, riparian corridors, and instream flows. Often, recoverable losses are used many times over by many downstream beneficiaries. To reduce these losses would deplete such supplies with no net gain in the total water supply. Their reduction, however, provide significant opportunities to contribute to the achievement of other CALFED objectives such as:

- improve instream water quality through reduced runoff of water laden with residual landscape chemicals, and other urban toxins that can flow into storm drains,
- reduce temperature impacts resulting from resident time of wastewater during treatment process
- reduce entrainment impacts to aquatic species as a result of reduced diversions, and
- reduce impacts on aquatic species, especially anadromous fish, through minor modifications in diversion timing and possibly provide in-basin benefits through subsequent modifications in the timing of reservoir releases.

Regional Conservation Estimates

Estimated water savings resulting from efficiency improvements are presented here for each of the urban zones defined previously in Section III, *Determination of Geographical Zones*. The values presented are only intended to provide input for purposes of a programmatic level impact analysis. These are estimated goals and should not be used for planning purposes. Estimates of potential reduction in losses from urban conservation measures are presented under one of two categories:

- Estimated Applied Water Reduction for Multiple Benefits
  - No Action condition (residential indoor, landscaping, Comm./Indust./Instit., system leak)
  - CALFED condition (residential indoor, landscaping, Comm./Indust./Instit., system leak)

- Estimated Real Water Savings for Reallocation to Other Water Supply Uses
  - No Action condition (residential indoor, landscaping, Comm./Indust./Instit., system leak)
  - CALFED condition (residential indoor, landscaping, Comm./Indust./Instit., system leak)

Estimated real water savings (reduced irrecoverable losses) can be viewed as a source of water that can be reallocated to other purposes such as meeting future urban needs, offsetting groundwater overdraft, or a transfer to other beneficial water supply uses, including the environment. Estimated applied water reductions do not generate a reallocable supply, but do provide other benefits desired by the CALFED Program.

Potential applied water reductions are included here for six of the seven urban zones. Reductions in the Colorado River Region would not directly translate to water quality or ecosystem benefits in the Bay-Delta watershed, and are therefore not included. Similarly, reduction of losses in the zones that import water from the Bay-Delta but are not tributary to the Delta (South Coast, Central Coast, and San Francisco Bay regions) can only provide an ecosystem benefit through reductions in diversions or modified diversion timing. They cannot benefit water quality because wastewater treatment plant return flows do not re-enter the Delta watershed. Other export areas whose return flows do re-enter the watershed can provide water quality as well as ecosystem benefits.

UR1 - Sacramento River

Overview

The Sacramento River region is defined by the Sacramento Valley, from Sacramento north to Redding. The area is predominantly in agriculture but many growing communities are within its boundary, including the greater metropolitan areas of Sacramento. All rivers that flow into the valley are carried by the Sacramento River southward to the Sacramento-San Joaquin Delta. Here, surface flows head west to the Pacific Ocean. With abundant surface and groundwater resources, urban users in this region experiences few water shortages. Sacramento Valley water users have some of the oldest rights to surface water, with some rights dating back to the gold rush era. Urban water use only comprises about 6 percent of the region's total water use. The more populated urban areas are located on the valley floor, where summer temperatures over 100 degrees are not uncommon.

The region is characterized by largely single family dwellings with relatively large landscapes, numerous processing and packing facilities for agricultural products, and limited manufacturing industry. For its size, the Sacramento River region is very sparsely populated, with an average density of fewer than 90 people per square mile. Most of these people live in the southern end of the region in and around Sacramento.

Typically, non-consumptive urban water use, such as indoor residential use and losses associated with landscape irrigation, tend to return to the system of rivers, streams, and aquifers. Water applied to the landscape in excess of landscape water requirements usually goes to the storm channels and back to the surface waters. Likewise, after treatment, municipal and indoor water use also ends up in the surface waters and is available for subsequent reuse. The region does not have significant irrecoverable losses, although water quality degradation does occur.

The potential for real water savings exists through the reduction in landscape water use and any potential reduction in consumption associated with commercial or industrial uses. Otherwise, conservation measures can only provide water quality, ecosystem, timing and energy savings benefits.

Urban populations are expected to grow significantly in the next 20 years, primarily around the greater Sacramento metropolitan area.

In this region 21 urban agencies have signed the Urban Memorandum of Understanding.

Urban Information

	Population	Baseline Per-capita water use
1995:	2.4 million	274 gpcd
2020:	3.9 million	257 gpcd (292 if no conservation occurs)

Approx. CII use in 1995: 35% of per capita use
Estimated CII use in 2020: 36% of per capita use
Assumed CII reduction as a result of conservation measures:
No Action: 15%
CALFED: 07%

Assumed residential indoor use (ave):
1995 80 gpcd
2020 No Action 70 gpcd
2020 CALFED 50-60 gpcd

Assumed distribution system losses (as a percent of total urban use):
Existing: 9%
No Action: 5%
CALFED: 5% (no change from No Action)

Assumed ratio of real water savings to applied water reduction: 0.05 (5%)

Assumed existing urban landscape acreage: 100,000 acres
Assumed urban landscaped acreage in 2020: 145,000 acres
Assumed ETo Value: 4.2 feet of water annually

Table: Assumed distribution of landscaped acreage (%) among ETo Factors

			2020 No Action		2020 CALFED	
ETo Factor	1995 Acres (%)	Base Acres (%)	Existing Acres (%)	New Acres (%)	Existing Acres (%)	New Acres (%)
1.2	100	100	50	30	40	10
1.0			25	30	30	10
0.8			25	40	30	75
0.6						5
0.4						

Estimated applied water reduction from conservation:

	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction (1,000 af/yr)
Residential Indoor [1]	40-45	65-70	105-115
Urban Landscaping [1]	100-105	30-35	130-140
Comm., Ind., Inst. [1]	65-70	25-30	90-100
Distribution System [1]	35-40	n/a	35-40
Total	240-260	120-135	360-395

1. It is assumed that, for this region, 95% of all conservation potential does not create any real water savings.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses:

As discussed above, the Sacramento River region is characterized as having significant amounts of incidental reuse, especially of indoor residential water. Most indoor use returns to local surface streams and rivers after treatment and is relied upon as part of downstream flows. In addition, changes in the type of outdoor landscaping are only assumed to have negligible savings. The region has little potential water savings that can be reallocated to other beneficial uses. It is true, however, that potential exists to implement urban conservation measures for other purposes, namely improved water quality, changed timing of flow releases, reduced fishery impacts, and reduced treatment costs. These quantities already appear in the table above.

	Projected Conservation under No Action (1,000 af/yr)	Incremental Conservation under CALFED (1,000 af/yr)	Total Conservation Potential (1,000 af/yr)
Residential Indoor [1]	1-3	3-5	4-8
Urban Landscaping [1,2]	4-5	2-4	6-9
Comm., Ind., Inst. [1]	3-4	1-2	4-6
Distribution System [1]	1-2	n/a	1-2
Total	10-15	5-10	15-25

1. It is assumed that, for this region, only 5% of all loss reduction results in real water savings.
2. Urban landscaping values include both reduction in losses from irrigation and modifications in the landscaping to types with lower overall water needs. See Supplement D for more details on determination of landscape conservation savings.

UR2 - Eastside San Joaquin River

Overview

The Eastside San Joaquin River region encompasses the area from the San Joaquin River near Fresno north to the Cosumnes River, and from the eastern foothills to San Joaquin River as it travels up the valley to the Delta. This area is predominantly agricultural but includes the metropolitan areas of Stockton, Modesto, and Merced along with numerous other communities. Several rivers originating in the Sierra Nevada flow out of the mountains and west into the San Joaquin River (as it travels through the center of the valley). These include the Merced, Tuolumne, Stanislaus, and Mokelumne Rivers as well as other small tributaries. Urban water use only comprises about 5 percent of the region's total water use. The more populated urban areas are located on the valley floor, where summer temperatures over 100 degrees are not uncommon.

With abundant surface and groundwater resources, urban users in this region experiences few water shortages. However, most of the urban communities in this region rely heavily on groundwater for municipal supplies. Recently, some agricultural irrigation districts in the region are developing agreements that would allow them to provide surface water to these communities as a supplemental source to the current groundwater supplies.

The region is characterized by largely single family dwellings with relatively large landscapes, numerous processing and packing facilities for agricultural products, and limited manufacturing industry. The region has an average population density of just under 200 people per square mile. Most of these people are concentrated in the urban towns and cities.

Typically, non-consumptive urban water use, such as indoor residential use and losses associated with landscape irrigation, tend to return to the system of rivers, streams, and aquifers. Water applied to the landscape in excess of landscape water requirements usually goes to the storm channels and back to the surface waters. Likewise, after treatment, municipal and indoor water use also ends up in the surface waters and is available for subsequent reuse. The region does not have significant irrecoverable losses, although water quality degradation does occur.

The potential for real water savings exists through the reduction in landscape water use and any potential reduction in consumption associated with commercial or industrial uses. Otherwise, conservation measures can only provide water quality, ecosystem, timing and energy savings benefits.

Urban populations are expected to grow significantly in the next 20 years, primarily around the cities of Stockton, Modesto and Merced. These areas increasingly will serve as "bedroom communities" for the Bay Area. In this region 6 urban agencies have signed the Urban Memorandum of Understanding.

Urban Information

	Population	Baseline Per-capita water use
1995:	1.6 million	301 gpcd
2020:	3.1 million	269 gpcd (306 if no conservation occurs)

Approx. CII use in 1995: 24% of per capita use
Estimated CII use in 2020: 25% of per capita use
Assumed CII reduction as a result of conservation measures:
No Action: 15%
CALFED: 07%

Assumed residential indoor use (ave):
1995 80 gpcd
2020 No Action 70 gpcd
2020 CALFED 50-60 gpcd

Assumed distribution system losses (as a percent of total urban use):
Existing: 6%
No Action: 5%
CALFED: 5% (no change from No Action)

Assumed ratio of real water savings to applied water reduction: 0.05 (5%)

Assumed existing urban landscape acreage: 65,000 acres
Assumed urban landscaped acreage in 2020: 120,000 acres
Assumed ETo Value: 4.3 feet of water annually

Table: Assumed distribution of landscaped acreage (%) in relation to ETo Factor

			2020 No Action		2020 CALFED	
ETo Factor	1995 Acres (%)	Base Acres (%)	Existing Acres (%)	New Acres (%)	Existing Acres (%)	New Acres (%)
1.2	85	85	50	30	20	5
1.0	10	10	25	30	40	5
0.8	5	5	25	40	40	80
0.6						10
0.4						

Estimated applied water reduction from conservation:

	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction (1,000 af/yr)
Residential Indoor [1]	30-35	45-50	75-85
Urban Landscaping [1]	65-70	60-65	125-135
Comm., Ind., Inst. [1]	35-40	15-20	50-60
Distribution System [1]	5-10	n/a	5-10
Total	135-155	120-135	255-290

1. It is assumed that, for this region, 95% of all conservation potential does not create any real water savings.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses:

As discussed above, the Eastside San Joaquin River region is characterized as having significant amounts of incidental reuse, especially of indoor residential water. Most indoor use returns to local surface streams and rivers after treatment and is relied upon as part of downstream flows. In addition, changes in the type of outdoor landscaping are only assumed to have negligible savings. The region has little potential water savings that can be reallocated to other beneficial uses. It is true, however, that potential exists to implement urban conservation measures for other purposes, namely improved water quality, changed timing of flow releases, reduced fishery impacts, and reduced treatment costs. These quantities already appear in the table above.

	Projected Real Water Savings under No Action (1,000 af/yr)	Incremental Real Water Savings under CALFED (1,000 af/yr)	Total Real Water Savings Potential (1,000 af/yr)
Residential Indoor [1]	1-3	2-4	3-7
Urban Landscaping [1,2]	3-4	6-8	9-12
Comm., Ind., Inst. [1]	2-3	0-1	2-4
Distribution System [1]	0-1	n/a	0-1
Total	5-10	5-10	10-20

1. It is assumed that, for this region, only 5% of all applied water reduction results in real water savings.
2. Urban landscaping values include both reduction in losses from irrigation and modifications in the landscaping to types with lower overall water needs. See Supplement D for more details on determination of landscape conservation savings.

UR3 - Tulare Lake

Overview

The Tulare Lake region includes the southern San Joaquin Valley from the southern limit of the San Joaquin River watershed to the base of the Tehachapi Mountains. The area is predominantly agricultural, but many small agricultural communities as well as the rapidly growing cities of Fresno and Bakersfield are located here. The Kings, Kaweah, Tule, and Kern Rivers flow into this region from the east. All of the rivers terminate in the valley floor, and do not drain to the ocean except in extremely wet years. Urban water use only comprises about 3 percent of the region's total water use. The more populated urban areas are located on the valley floor, where summer temperatures over 100 degrees are not uncommon.

The region is characterized by mainly single family dwellings with large rural landscapes. The region has large amount of dairy operations, processing and packing industries for agricultural products, and very little or no industrial manufacturing activities, beyond the extraction of oil from subterranean reserves. This primarily occurs south and west of Bakersfield and does not constitute a large municipal water demand. The region has an average population density of just over 100 people per square mile. Most of these people are concentrated in the urban towns and cities.

Like other Central Valley regions, municipal and residential water reuse is common. Landscape water runoff often percolates to the groundwater since the region is a closed basin. However, after being treated in wastewater treatment plants, the majority of the treated water is evaporated in large evaporation ponds. Some of this water also percolates downward and provides recharge to local groundwater sources. In many parts shallow groundwater has become salty and in some cases, contaminated with selenium. Significant amount of surface runoff from landscape percolates to shallow groundwater and may become unusable. Likewise, after treatment municipal water is reused for agricultural irrigation or used to recharge groundwater.

Urban populations are expected to grow significantly in the next 20 years, primarily around the cities of Bakersfield and Fresno. Bakersfield is experiencing rapid growth because of influences from nearby metropolitan southern California.

In this region, 6 urban agencies have signed the Urban Memorandum of Understanding.

Urban Information

	Population	Baseline Per-capita water use
1995:	1.7 million	311 gpcd
2020:	3.3 million	274 gpcd (304 if no conservation occurs)

Approx. CII use in 1995: 24% of per capita use
Estimated CII use in 2020: 25% of per capita use
Assumed CII reduction as a result of conservation measures:
No Action: 15%
CALFED: 07%

Assumed residential indoor use (ave):
1995 80 gpcd
2020 No Action 70 gpcd
2020 CALFED 50-60 gpcd

Assumed distribution system losses (as a percent of total urban use):
Existing: 9%
No Action: 5%
CALFED: 5% (no change from No Action)

Assumed ratio of real water savings to applied water reduction: 0.3 (30%)

Assumed existing urban landscape acreage: 70,000 acres
Assumed urban landscaped acreage in 2020: 130,000 acres
Assumed ETo Value: 4.3 feet of water annually

Table: Assumed distribution of landscaped acreage (%) in relation to ETo Factor

			2020 No Action		2020 CALFED	
ETo Factor	1995 Acres (%)	Base Acres (%)	Existing Acres (%)	New Acres (%)	Existing Acres (%)	New Acres (%)
1.2	15	15	10	10	5	0
1.0	60	60	60	30	50	10
0.8	25	25	30	60	45	70
0.6						20
0.4						

Estimated applied water reduction from conservation:

	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction (1,000 af/yr)
Residential Indoor [1]	30-35	50-55	80-90
Urban Landscaping [1]	20-25	40-45	60-70
Comm., Ind., Inst. [1]	40-45	15-20	55-65
Distribution System [1]	25-30	n/a	25-30
Total	115-135	105-120	220-255

1. It is assumed that, for this region, 70% of all conservation potential does not create any real water savings.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses:

As discussed above, the Tulare Lake region is characterized as having incidental reuse, especially of indoor residential water. Some indoor use percolates to groundwater after treatment and is relied upon as a groundwater source, especially for agricultural users adjacent to wastewater treatment plant disposal areas. However, there is also significant evaporation of water after being treated at regional treatment plants. Reductions in the amount of evaporation loss can be a real water savings.

Changes in the type of outdoor landscaping are also assumed to have some savings. The region does have potential water savings that can be reallocated to other beneficial uses. It is true, however, that additional potential exists to implement urban conservation measures for other purposes, namely improved water quality, changed timing of flow releases, reduced fishery impacts, and reduced treatment costs. These quantities already appear in the table above.

	Projected Real Water Savings under No Action (1,000 af/yr)	Incremental Real Water Savings under CALFED (1,000 af/yr)	Total Real Water Savings Potential (1,000 af/yr)
Residential Indoor [1]	10-15	15-20	25-35
Urban Landscaping [1,2]	7-9	18-21	25-30
Comm., Ind., Inst. [1]	10-15	4-6	15-20
Distribution System [1]	5-10	n/a	5-10
Total	30-50	35-45	65-95

1. It is assumed that, for this region, 30% of all applied water reduction results in real water savings.
2. Urban landscaping values include both reduction in losses from irrigation and modifications in the landscaping. See Supplement D for more details on determination of landscape conservation savings.

UR4 - San Francisco Bay

Overview

The San Francisco Bay region is primarily urban with very little agricultural acreage. The region represents merely 3 percent of the States's land. The region generally is cool and often foggy along the coast, with Mediterranean-like weather in its inland valleys. The coastal range creates numerous micro-climates and allows cool air to flow at times from the Pacific Ocean into the interior of the State. Coastal areas are often about 10 degrees cooler than interior part of the region, and sometimes as much as 20 to 30 degrees cooler in summer months than the regions of the Central Valley. In contrast to the Sacramento and Tulare regions, this region's urban demand accounts for 20 percent of the total demand. (Environmental use is a little less than of 80% of the total).

The region is characterized by single and multi family dwellings with smaller landscapes, large amounts of industry, including computer and electronics manufacturing, and many commercial businesses. The commercial and industrial water demands can be significant, accounting for almost one third of the total urban demand. The region is heavily populated and has an average density of over 1300 people per square mile.

Unlike the Central Valley regions, downstream reuse of landscape runoff and treated wastewater is very minimal. The majority of unconsumed urban water ends up in the San Francisco Bay or is directly discharged to the Pacific Ocean. There is little opportunity for incidental reuse. For this reason, there is an increasing interest in capturing the discharges and recycling them back into the region. However, conservation measures can also help reduce the irrecoverable losses to these salt sinks. Any decrease in water use in this region, whether previously consumed or not, can generate real water savings.

Urban populations are expected to only expand slightly, primarily because of limited land as well as other resources. However, limited growth can still be significant when compared to the total projected populations in Central Valley regions.

In this region 27 urban water agencies have signed the Urban Memorandum of Understanding.

Urban Information

	Population	Baseline Per-capita water use
1995:	5.8 million	177 gpcd
2020:	6.9 million	169 gpcd (199 if no conservation occurs)

Approx. CII use in 1995:	38% of per capita use
Estimated CII use in 2020:	38% of per capita use

Assumed CII reduction as a result of conservation measures:

No Action:	20%
CALFED:	05%

Assumed residential indoor use (ave):

1995	80 gpcd
2020 No Action	65 gpcd
2020 CALFED	50-60 gpcd

Assumed distribution system losses (as a percent of total urban use):

Existing:	8%
No Action:	5%
CALFED:	5% (no change from No Action)

Assumed ratio of real water savings to applied water reduction: 0.9 (90%)

Assumed existing urban landscape acreage: 155,000 acres
Assumed urban landscaped acreage in 2020: 180,000 acres
Assumed ETo Value: 3.3 feet of water annually

Table: Assumed distribution of landscaped acreage (%) in relation to ETo Factor

			2020 No Action		2020 CALFED	
ETo Factor	1995 Acres (%)	Base Acres (%)	Existing Acres (%)	New Acres (%)	Existing Acres (%)	New Acres (%)
1.2	15	15	10	10	0	0
1.0	60	60	50	30	35	20
0.8	25	25	40	60	55	55
0.6					10	20
0.4						5

Estimated applied water reduction from conservation:

As discussed above, the San Francisco region is characterized as having the majority of losses associated with urban water use considered irrecoverable. This is primarily a result of direct discharges from wastewater treatment plants to the San Francisco Bay and the Pacific Ocean. Though not all of the savings from conservation can be reallocated to other uses, the total applied water savings estimated could result in water quality, ecosystem, flow timing, and energy savings benefits.

	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction (1,000 af/yr)
Residential Indoor [1]	110-120	70-80	180-200
Urban Landscaping [1]	25-30	55-60	80-90
Comm., Ind., Inst. [1]	110-120	20-25	130-145
Distribution System [1]	35-40	n/a	35-40
Total	280-310	145-165	425-475

1. It is assumed that, for this region, only 10% of all conservation potential does not create any real water savings.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses:

Most of the conservation potential in this region would result in real water savings that could be made available to other beneficial uses, including offsetting future urban demands. Such savings would also have the benefits described for applied water reduction.

	Projected Real Water Savings under No Action (1,000 af/yr)	Incremental Real Water Savings under CALFED (1,000 af/yr)	Total Real Water Savings Potential (1,000 af/yr)
Residential Indoor [1]	100-110	65-70	165-180
Urban Landscaping [1,2]	20-25	50-55	70-80
Comm., Ind., Inst. [1]	100-110	20-25	120-135
Distribution System [1]	30-35	n/a	30-35
Total	250-280	135-150	385-430

1. It is assumed that, for this region, 90% of all loss reduction results in real water savings.
2. Urban landscaping values include both reduction in losses from irrigation and modifications in the landscaping to types with lower overall water needs. See Supplement D for more details on determination of landscape conservation savings.

UR5 - Central Coast

Overview

The Central Coast region encompasses land on the western side of the coastal mountains that is hydraulically connected to the Bay-Delta region. This includes southern portions of the Santa Clara Valley and San Benito County, as well as the urban communities from San Luis Obispo south to Santa Barbara. These areas are included because of the recent completion of the Coastal Aqueduct, envisioned to provide State Water Project water to urban users along its route. Exported water from the San Felipe unit of the Central Valley Project is delivered to urban users in San Benito and Santa Clara counties. In contrast to the Sacramento and Tulare regions, this region's urban demand accounts for 20 percent of the total demand. (Agriculture uses just less than 80% of the total).

The region has a diverse climate with summer months cool along the coastal areas and warm inland. During the winter, however, interior parts of the region become cooler than coastal areas. The region is characterized by largely single family dwellings with relatively small landscapes, and limited commercial and industrial operations. The region has an average population density of just under 120 people per square mile. Most of these people are concentrated in the urban towns and cities.

Unlike the Central Valley regions, downstream reuse of landscape runoff and treated wastewater is very minimal. The majority of unconsumed urban water is directly discharged to the Pacific Ocean. There is little opportunity for incidental reuse. For this reason, there is an increasing interest in capturing the discharges and recycling them back into the region. However, conservation measures can also help reduce the irrecoverable losses to these salt sinks. Any decrease in water use in this region, whether previously consumed or not, can generate real water savings.

In this region 13 urban agencies have signed the Urban Memorandum of Understanding.

Urban Information

	Population	Baseline Per-capita water use
1995:	1.3 million	180 gpcd
2020:	1.9 million	164 gpcd (192 if no conservation occurs)

Approx. CII use in 1995: 32% of per capita use
Estimated CII use in 2020: 33% of per capita use
Assumed CII reduction as a result of conservation measures:
No Action: 10%
CALFED: 10%

Assumed residential indoor use (ave):

1995	70 gpcd
2020 No Action	65 gpcd
2020 CALFED	50-60 gpcd

Assumed distribution system losses (as a percent of total urban use):

Existing:	10%
No Action:	5%
CALFED:	5% (no change from No Action)

Assumed ratio of real water savings to applied water reduction: 1.0 (100%)

Assumed existing urban landscape acreage:	35,000 acres
Assumed urban landscaped acreage in 2020:	50,000 acres
Assumed ETo Value:	2.8 feet of water annually

Table: Assumed distribution of landscaped acreage (%) in relation to ETo Factor

			2020 No Action		2020 CALFED	
ETo Factor	1995 Acres (%)	Base Acres (%)	Existing Acres (%)	New Acres (%)	Existing Acres (%)	New Acres (%)
1.2	5	5	3	0	0	0
1.0	20	20	15	10	5	0
0.8	55	55	40	30	25	15
0.6	20	20	42	55	60	65
0.4				5	10	20

Estimated applied water reduction from conservation:

As discussed above, the Central Coast region is characterized as having all losses associated with urban water use considered irrecoverable. This is primarily a result of direct discharges from wastewater treatment plants to the Pacific Ocean. Though not all of the savings from conservation can be reallocated to other uses, the total applied water savings estimated could result in water quality, ecosystem, flow timing, and energy savings benefits.

	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction (1,000 af/yr)
Residential Indoor [1]	10-15	20-25	30-40
Urban Landscaping [1]	10-12	14-16	24-28
Comm., Ind., Inst. [1]	10-15	10-15	20-30
Distribution System [1]	15-20	n/a	15-20
Total	45-65	45-55	90-120

1. It is assumed that, for this region, 0% of the conservation potential does not create any real water savings.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses:

Most of the conservation potential in this region would result in real water savings that could be made available to other beneficial uses, including offsetting future urban demands. Such savings would also have the benefits described for applied water reduction.

	Projected Real Water Savings under No Action (1,000 af/yr)	Incremental Real Water Savings under CALFED (1,000 af/yr)	Total Real Water Savings Potential (1,000 af/yr)
Residential Indoor [1]	10-15	20-25	30-40
Urban Landscaping [1,2]	10-12	14-16	24-28
Comm., Ind., Inst. [1]	10-15	10-15	20-30
Distribution System [1]	15-20	n/a	15-20
Total	45-65	45-55	90-120

1. It is assumed that, for this region, 100% of all loss reduction results in real water savings.
2. Urban landscaping values include both reduction in losses from irrigation and modifications in the landscaping to types with lower overall water needs. See Supplement D for more details on determination of landscape conservation savings.

UR6 - South Coast

Overview

The South Coast Region lies south of the Tehachapi Mountains and extends to the California border with Mexico. It is home for more than 50 percent of the state's population but only 7 percent of the state's total land area. Rivers and streams that originate in this region flow toward the Pacific Ocean. The climate is Mediterranean-like, with warm and dry summers followed by mild and wet winters. It is projected that the region will increase from a 1990 population of 16 million to over 25 million by 2020. In sharp contrast to all the other regions, this region's urban demand accounts for 80 percent of the total demand. The region also imports about two thirds of its water from areas outside the region, including the Colorado River, the Owens Valley, and the Bay-Delta.

The region is characterized by single and multi family dwellings with smaller landscapes, large amounts of industry, and many commercial businesses. The commercial and industrial water demands can be significant, accounting for over one quarter of the total urban demand. This region also has the highest population density with nearly 1,600 people per square mile of land.

Unlike the Central Valley regions, downstream reuse of landscape runoff and treated wastewater is very minimal. The majority of unconsumed urban water is directly discharged to the Pacific Ocean. There is little opportunity for incidental reuse. For this reason, there is an increasing interest in capturing the discharges and recycling them back into the region. However, conservation measures can also help reduce the irrecoverable losses to these salt sinks. Any decrease in water use in this region, whether previously consumed or not, can generate real water savings.

In this region 89 urban agencies have signed the Urban Memorandum of Understanding.

Special Conditions

The hot and dry climate in the region demands higher rates of evapotranspiration and overall water use to satisfy landscape water requirements. The region has a significant amount of landscaped acreage, accounting for about half the statewide estimated total. In addition, the area has experienced groundwater overdraft and degradation of many of the aquifers, several of which have been adjudicated and are under intense management.

Urban Information

	Population	Baseline Per-capita water use
1995:	17.3 million	208 gpcd
2020:	24.3 million	186 gpcd (218 if no conservation occurs)

Approx. CII use in 1995: 32% of per capita use
Estimated CII use in 2020: 32% of per capita use
Assumed CII reduction as a result of conservation measures:
No Action: 20%
CALFED: 05%

Assumed residential indoor use (ave):
1995 85 gpcd
2020 No Action 65 gpcd
2020 CALFED 50-60 gpcd

Assumed distribution system losses (as a percent of total urban use):
Existing: 9%
No Action: 5%
CALFED: 5% (no change from No Action)

Assumed ratio of real water savings to applied water reduction: 0.8 (80%)

Assumed existing urban landscape acreage: 480,000 acres
Assumed urban landscaped acreage in 2020: 650,000 acres
Assumed ETo Value: 4.0 feet of water annually

Table: Assumed distribution of landscaped acreage (%) in relation to ETo Factor

			2020 No Action		2020 CALFED	
ETo Factor	1995 Acres (%)	Base Acres (%)	Existing Acres (%)	New Acres (%)	Existing Acres (%)	New Acres (%)
1.2	10	10	5	0	0	0
1.0	40	40	30	20	15	5
0.8	40	40	50	60	60	55
0.6	10	10	13	15	20	30
0.4			2	5	5	10

Estimated applied water reduction from conservation:

As discussed above, the South Coast region is characterized as having most of its losses associated with urban water use considered irrecoverable. This is primarily a result of direct discharges from wastewater treatment plants to the Pacific Ocean. Though not all of the savings from conservation can be reallocated to other uses, the total applied water savings estimated could result in water quality, ecosystem, flow timing, and energy savings benefits.

	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction (1,000 af/yr)
Residential Indoor [1]	520-540	260-270	780-810
Urban Landscaping [1]	170-190	190-200	360-390
Comm., Ind., Inst. [1]	350-375	50-75	400-450
Distribution System [1]	170-190	n/a	170-190
Total	1,210-1,295	500-545	1,710-1,840

1. It is assumed that, for this region, only 20% of the conservation potential does not create any real water savings.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses:

Most of the conservation potential in this region would result in real water savings that could be made available to other beneficial uses, including offsetting future urban demands. Such savings would also have the benefits described for applied water reduction.

	Projected Real Water Savings under No Action (1,000 af/yr)	Incremental Real Water Savings under CALFED (1,000 af/yr)	Total Real Water Savings Potential (1,000 af/yr)
Residential Indoor [1]	420-430	210-220	630-650
Urban Landscaping [1,2]	150-160	170-180	320-340
Comm., Ind., Inst. [1]	280-300	50-60	330-360
Distribution System [1]	130-150	n/a	130-150
Total	980-1,040	430-460	1,410-1,500

1. It is assumed that, for this region, 80% of all loss reduction results in real water savings.
2. Urban landscaping values include both reduction in losses from irrigation and modifications in the landscaping to types with lower overall water needs. See Supplement D for more details on determination of landscape conservation savings.

UR7 - Colorado River

Overview

The Colorado Region includes a large area of the State's southeastern corner, the majority of which is desert or irrigated agriculture. The primary urban areas lie north and south of the Salton Sea. The resort oriented communities of Palm Springs and Indio lie to the north, while the rural communities of Imperial and Brawley lie to the south. This area includes about 650,000 acres of irrigated land. The Salton Sea, located between the two urban areas, is a prominent feature. The Sea is currently fed by rainfall from the surrounding desert mountains and by agricultural surface drainage. Rainfall in the mountains also recharges the groundwater aquifers that underlie the region. Groundwater plays a major role in providing for the urban demands, including the significant acreage devoted to golf courses. However, urban water use only comprises about 5 percent of the region's total water use (agriculture uses 83 percent).

The region's climate is hot subtropical desert with most of the annual precipitation falling as snow in the surrounding high mountains. It is not uncommon to have temperature above 110 degrees during the summer months.

The region is characterized by single family dwellings, some with large turf landscapes, others with desert landscape, commercial businesses, and resorts. The resort demand alone creates a significant need for water resources. The region has an average population density of around 25 people per square mile. Most of these people are concentrated in the urban towns and cities, not in the outlying desert or the Salton Sea area.

Unlike the Central Valley regions, downstream reuse of landscape runoff and treated wastewater is very minimal. Though there is some groundwater reuse associated with the resort golf areas, the majority of urban water that is not consumptively used eventually reaches the Salton Sea. There is little opportunity for incidental reuse. Conservation measures can help reduce the irrecoverable losses to this salt sink. Any decrease in water use in this region, whether previously consumed or not, can generate real water savings.

In this region 5 urban agencies have signed the Urban Memorandum of Understanding.

Special Conditions:

Similar to agricultural conservation opportunities, the potential for real water savings to benefit the Bay-Delta is dependent on the use of the conserved water. For example, conservation savings in Palm Springs may be used to offset future demands. It is unlikely that savings would be transferred to another urban user as a replacement for imported Delta water. Therefore, the values shown for this region may do little to benefit the Bay-Delta.

Urban Information

	Population	Baseline Per-capita water use
1995:	0.5 million	578 gpcd
2020:	1.1 million	522 gpcd (594 if no conservation occurs)

Approx. CII use in 1995: 27% of per capita use
Estimated CII use in 2020: 28% of per capita use
Assumed CII reduction as a result of conservation measures:
No Action: 10%
CALFED: 10%

Assumed residential indoor use (ave):
1995 85 gpcd
2020 No Action 65 gpcd
2020 CALFED 50-60 gpcd

Assumed distribution system losses (as a percent of total urban use):
Existing: 14%
No Action: 5%
CALFED: 5% (no change from No Action)

Assumed ratio of real water savings to applied water reduction: 0.9 (90%)

Assumed existing urban landscape acreage: 35,000 acres
Assumed urban landscaped acreage in 2020: 75,000 acres
Assumed ETo Value: 6.0 feet of water annually

Table: Assumed distribution of landscaped acreage (%) in relation to ETo Factor

			2020 No Action		2020 CALFED	
ETo Factor	1995 Acres (%)	Base Acres (%)	Existing Acres (%)	New Acres (%)	Existing Acres (%)	New Acres (%)
1.2	70	70	60	50	50	40
1.0	30	30	35	40	30	30
0.8			5	10	15	25
0.6					5	5
0.4						

Estimated applied water reduction from conservation:

As discussed above, the Colorado River region is characterized as having most of its losses associated with urban water use considered irrecoverable. This is primarily a result of direct discharges from wastewater treatment plants to surface waters that flow to the Salton Sea and evaporation ponds that dissipate the treated wastewater. Though not all of the savings from conservation can be reallocated to other uses, the total applied water savings estimated could result in water quality, ecosystem, flow timing, and energy savings benefits.

	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction (1,000 af/yr)
Residential Indoor [1]	25-30	10-15	35-45
Urban Landscaping [1]	20-25	25-30	45-55
Comm., Ind., Inst. [1]	15-20	15-20	30-40
Distribution System [1]	35-40	n/a	35-40
Total	95-115	50-65	145-180

1. It is assumed that, for this region, only 10% of the conservation potential does not create any real water savings.

Estimated Real Water Savings for Reallocation to Other Water Supply Uses:

Most of the conservation potential in this region would result in real water savings that could be made available to other beneficial uses, including offsetting future urban demands. Such savings would also have the benefits described for applied water reduction.

	Projected Real Water Savings under No Action (1,000 af/yr)	Incremental Real Water Savings under CALFED (1,000 af/yr)	Total Real Water Savings Potential (1,000 af/yr)
Residential Indoor [1]	20-25	10-15	30-40
Urban Landscaping [1,2]	18-20	24-26	42-46
Comm., Ind., Inst. [1]	15-20	15-20	20-30
Distribution System [1]	30-35	n/a	30-35
Total	85-100	50-60	135-160

1. It is assumed that, for this region, 90% of all loss reduction results in real water savings.
2. Urban landscaping values include both reduction in losses from irrigation and modifications in the landscaping to types with lower overall water needs. See Supplement D for more details on determination of landscape conservation savings.

Summary of Estimated Urban Real Water Savings

The following is a summary table presenting the total estimated reduction in irrecoverable losses through urban water conservation measures for the urban zones discussed above. It is assumed that the water associated with these reductions could be reallocated to other water supply uses. However, the values shown are only for purposes of programmatic level impact analysis and should not be used for planning purposes.

Table 5.4 - Estimated Real Water Savings for Reallocation to Other Water Supply Uses

	Projected Real Water Savings under No Action (1,000 af/yr)	Incremental Real Water Savings under CALFED (1,000 af/yr)	Total Real Water Savings Potential (1,000 af/yr)
Sacramento	10-15	5-10	15-25
East SJR	5-10	5-10	10-20
Tulare	30-50	35-45	65-95
San Francisco	250-280	135-150	335-430
Central Coast	45-65	45-55	90-120
South Coast	980-1,040	430-460	1,410-1,500
Colorado	85-100	50-60	135-160
Total	1,405-1,560	705-790	2,110-2,350

Summary of Estimated Urban Applied Water Reduction

The following is a summary table presenting the total estimated applied water reduction resulting from urban conservation measures for the urban zones discussed above. It is assumed that water associated with these reductions beyond those already accounted for under the 'real water savings table' above can not be reallocated to other water supply uses. The savings, though, can have water quality, flow timing, ecosystem health, and energy reduction benefits. For this reason, the Colorado River region is not included since reduction of application of Colorado River water cannot generate water quality or environmental benefits in the Delta. Values shown are for sole purposes of programmatic impact analysis and should not be used for any planning efforts.

Table 5.5 - Estimated Applied Water Reductions

	Projected Applied Water Reduction for No Action (1,000 af/yr)	Incremental Applied Water Reduction for CALFED (1,000 af/yr)	Total Applied Water Reduction (1,000 af/yr)
Sacramento	240-260	120-135	360-395
East SJR	135-155	120-135	255-290
Tulare	115-135	105-120	220-255
San Francisco	280-310	145-165	425-475
Central Coast	45-65	45-55	90-120
South Coast	1,210-1,295	500-545	1,710-1,840
Total	2,025-2,220	1,035-1,150	3,060-3,370

Estimated Cost of Efficiency Improvements

Reducing recoverable and irrecoverable losses by implementing conservation measures will require additional expenditures by water supplier as well as customers. These costs result from various changes such as improvements in retail delivery systems, changes to district operation and maintenance, installation of new customer plumbing fixtures and appliances, and changes in landscaping materials and practices. Estimated costs presented in this document do not attempt to allocate the costs to any particular beneficiaries (customers, water suppliers, society) or to determine if implementation of particular measures is cost-effective. Analysis of the cost-effectiveness of various efficiency measures and who will pay will be determined locally on a case-by-case basis during planning and implementation.

Cost of Reducing Applied Water vs. Cost of Real Water Savings

Implementation of specific water delivery improvements, whether at the customer or the district level, will cost relatively the same whether in the Sacramento Valley or in San Diego. This is because the cost of new plumbing fixtures, distribution pipelines, landscape materials, and higher levels of management does not vary significantly throughout the state. What does vary, however, is the associated reduction in losses. The percentage of applied water that results in recoverable and irrecoverable losses depends on the geographic location (coastal or inland), how water is used by residential, commercial and other sectors, district water supply management and operation, the hydrologic conditions, the soils, and other physical and economic factors.

The cost to reduce applied water losses, regardless of whether recoverable or irrecoverable, can be described in terms of dollars per acre-foot per year. This value would include the capital cost of any system improvements, plumbing changes, etc., amortized over the life of the system, and increased costs of operation, maintenance, and management of the system, divided by the potential water savings (in acre-feet annually) that are anticipated to result from implementing the improvements. This value represents the cost to reduce total losses (irrecoverable and recoverable). The cost associated with real water savings (reduction in irrecoverable losses) will be at least as great as that for applied water reduction and in some cases, even greater, for reasons explained below.

The majority of urban water use occurs in coastal regions. Water used in residences, commercial and industrial applications, and other sectors, is often directed to wastewater treatment plants after customer use. Here the waste flow is cleaned and resulting water is discharged to local receiving bodies. In coastal areas, these receiving bodies are often saline sinks, such as the Pacific Ocean or the San Francisco Bay. In these situations, the vast majority of water, on a regional basis, is considered irrecoverable (a smaller percentage may be discharged to coastal fresh water rivers or local aquifers and is considered part of the local water supply). As shown in the previous section detailing the values for each region, percentages of applied water that resulted in irrecoverable losses range from 5 percent in the Central Valley to 100 percent for the Central Coast. The percentage in coastal areas collectively ranges from 80 percent for southern California to 100 percent for the Central Coast.

Because nearly all losses in coastal regions are irrecoverable, each acre-foot reduction in applied water is nearly an acre-foot savings of real water. Therefore, the difference between the cost for applied water savings versus real water savings is minimal. However, in interior areas, such as the Sacramento Valley, the irrecoverable portion is very small. To generate 1 acre-foot of real water savings, where only 5 percent of the losses are deemed irrecoverable, 20 acre-feet of applied water reduction would be needed. The cost, therefore, would accordingly be multiplied by 20. Since estimates of irrecoverable loss for the Sacramento River and San Joaquin River regions are nominal (see Table 5.4), the cost for irrecoverable losses is not calculated

The analysis below uses a range of irrecoverable loss from 80 to 100 percent of total loss, based on estimates of the ratio of applied water reduction to real water savings shown previously (the estimates have been adopted from the Department of Water Resources' Bulletin 160-93 information). The Tulare Lake region is an exception. In this region, irrecoverable losses are 30 percent of each acre-foot of reduction (also derived fro the Bulletin 160-93 information).

Estimated Cost for Customer Level Conservation Measures

Cost estimates for urban conservation measures implemented at the customer level are based on several studies analyzed by Department of Water Resources staff. These studies include work done by East Bay Municipal Utilities District, Marin Municipal Water District, Metropolitan Water District of Southern California, as well as others. The studies estimated the costs and performance characteristics of many different water conservation measures implemented at the customer level. Example measures include: residential and commercial ultra low flush toilets, low flow showerheads, horizontal axis clothes washers, landscape audits, commercial/industrial process conservation, and landscape replacement.

For each measure, estimates have been made to determine the annual cost incurred per acre-foot of savings gained. These are shown in Table 5.8. As seen when looking at the table, the cost to install customer-level conservation measures varies tremendously. This is because of the wide variation in the savings that accompany each measure and the capital and/or operational cost of a particular measure. For example, though it may be relatively inexpensive to fix a toilet leak, many toilets have to be tested for leaks and fixed before an acre-foot of savings accumulates. This results in a higher cost that if each toilet was simply replaced.

The measures that may be implemented within a particular water district's service area will depend on the local conditions. This in turn will affect the average cost per acre-foot of implementation. In some service areas, the predominant customer is commercial and/or industrial, for other service areas it may be residential. Without a detailed evaluation, it can be extremely difficult to estimate the average cost per-acre foot of savings for any particular region. Another added complication is the level of particular conservation measures already implemented in a particular service area.

Table 5.8 - Urban Conservation Cost Estimates for Measures Implemented at the Customer Level

Conservation Measure	Cost per acre-foot of savings ($/af/year)
Residential water audits	300-500
Toilet dams	70
Repair toilet leaks	750
Residential/Commercial ULF toilets	300-500
Low flow showerheads	150-250
Commercial self-closing faucets	1,800
Horizontal axis clothes washer	1,900
Landscape audits (large turf areas)	350-600
Improve commercial landscape irrigation system	1,200
Landscape replanting (from high turf area to low turf area or Mediterranean landscape or xeriscape)	200-2,000

Note: Information in this table is from a September 1997 summary by DWR staff of various cost studies done by several urban water suppliers. The cost per acre-foot is mainly dependent on the amount of savings assumed for each measure. Potential savings values were included in the water district studies but are not shown here.

For example, if many of the residences in one service area have already installed ultra low flush toilets (UFLTs), then other, probably more expensive measures have to be implemented. Conversely, in an area with few ULFTS, installation of these may dominate the local conservation strategy. However, to achieve the levels of conservation anticipated under the CALFED alternatives, most of the measures would ultimately be implemented. This will tend to reduce, but not eliminate, this regional discrepancy. For purposes of cost estimates in this document, the following assumptions are made:

- The interior regions (Sacramento, San Joaquin, and Tulare) have implemented less conservation to date. Therefore, they will have a slightly lower average cost per acre-foot of applied water savings
- Coastal regions have tended to implement some of the lower cost measures already, and therefore, are expected to have slightly higher average cost per acre-foot of savings.
- Residential use dominates the demand so conservation programs will tend to focus on them. Accordingly, the unit cost of residential conservation measures is weighted more heavily than

commercial or industrial measures in determining average cost. Residential measures primarily focus on indoor uses. For purposes of this analysis, the impact of the cost of landscaping improvements on the average price is assumed to be minimal.

Based on the above assumptions, the following average annual cost per acre-foot of savings are assumed for each of the seven urban regions:

Table 5.9 - Range of Costs to Achieve Various Customer Level Conservation Improvements in each Region

	Cost per Acre-foot of Applied Water Reduced ($/af/yr)	Irrecoverable Loss Identified (see Table 5.4)	Cost per Acre-foot of Irrecoverable Loss Saved[1] ($/af/yr)
Sacramento	300 - 500	minimal	--
East SJR	300 - 500	minimal	--
Tulare	300 - 500	yes (30%)	1,000 - 1,600
San Francisco	400 - 600	yes (90%)	440 - 660
Central Coast	400 - 600	yes (100%)	400 - 600
South Coast	400 - 600	yes (80%)	500 - 750
Colorado	-- [2]	yes (90%)	440 - 660 [2]

1. Cost shown for reducing irrecoverable losses are based on assuming 80 to 100% of each acre-foot of applied water reduction is irrecoverable according to percentages described under the regional descriptions (i.e., costs are multiplied from 1 to 1.25 times the cost of applied water savings, depending on the region).
Cost shown for the Tulare Region are based on assuming 30% of each acre-foot of applied water reduction is irrecoverable (i.e., costs are multiplied 3.3 times the cost of applied water savings).
2. Colorado region has no water quality or ecosystem benefits that can be translated to the Bay-Delta so estimates of applied water reduction were not made. Cost for irrecoverable loss reduction is based on the cost for the San Francisco region.

Estimated Water Supplier Conservation Improvement Costs

In addition to the cost of implementing customer level BMPS, as depicted in Table 5.9, there will be costs that the water supplier or other local agency may incur to support and administer conservation programs and to perform supplier level improvements, such as system leak reductions. Without support of the local agencies and other conservation-oriented entities, such as DWR's Office of Water Conservation, achieving higher levels of water use efficiency can be much more difficult. Estimates of water supplier costs were made using information obtained from 20 local water supplier agencies throughout the state and data from the Department of Water Resources. Because of the unique situation for each water supplier, it is difficult to generalize these costs. Costs can vary greatly project to project, even in the same region for the same type of project. However, costs estimates are presented here for purposes of aiding in the programmatic level impact analysis.

Table 5.10 summarizes the estimated costs to provide conservation programs and system leak reduction for each of the urban regions. It should be noted that the cost for reducing system losses (leak reduction) does not represent the cost to reduce losses that may occur on the customer side of a meter. These should already be accounted for as part of the Table 5.9 values. It is estimated that the administration costs for a system leak repair program can add as much as 15 percent to the total project costs. This has been accounted for in the values below.

Table 5.10 - Estimated Water Supplier Conservation Improvement Costs to Move Beyond Baseline Conditions (No Action or CALFED) ($/year)

	Cost to Support Customer-Level Conservation Improvements [1]	Cost For Reduction in Water Supplier System Leaks [2]	Total Cost to the Water Supplier	Average Cost per Capita ($/person/yr)[3]
Sacramento	13,000,000	1,500,000	14,500,000	3.70
East SJR	5,000,000	1,200,000	6,200,000	2.00
Tulare	5,000,000	1,200,000	6,200,000	1.90
San Francisco	15,000,000	2,500,000	17,600,000	2.60
Central Coast	7,000,000	750,000	7,760,000	4.10
South Coast	67,000,000	9,500,000	76,600,000	3.20
Colorado	9,000,000	350,000	9,380,000	8.50

1. Values are an estimate of the additional dollars necessary to move beyond current conservation programs. This may include adding more agency personnel and increased operational expenses to provide conservation programs such as toilet replacements, school education, etc. The cost will vary regionally because of the differing population densities, level and types of conservation programs currently implemented, and customer needs.
2. System leak reduction costs were calculated based on the past two decades of DWR's loan program targeting mainline replacement. The history of these programs indicates that system leak reduction averages $24/acre-foot of conserved water. The loan programs have provided about $45 million over the past 15 years. However, the DWR loan program is assumed to only represent about 1/5 of the total system leak reduction actions occurring statewide. Based on this, it is assumed that an additional $15 to $20 million a year is needed to increase system leak repair programs statewide to sufficient levels to reduce system losses to 5 percent.
3. Average cost per capita is the total water supplier cost divided by the region's population (see Figure 5.4 for 2020 population estimates).

6. Water Recycling

Water recycling offers significant potential to improve water supply reliability for California, one of the primary objectives of the CALFED Program. Water recycling is a safe, reliable, and locally controlled water supply. Tertiary treated, disinfected recycled water is permitted for all non-potable uses in California through Title 22 of the Health and Safety Code. With the majority of the state's population in coastal areas, the majority of resulting wastewater flows are currently discharged to the ocean and rendered unavailable for reuse. If these flows are recycled, they can represent a new and somewhat drought-proof source of supply for water users.

Currently, the total agricultural and urban water use in the state is about 42 million acre-feet annually. Of this, the urban sector uses about 8.7 million acre-feet, nearly 70 percent of which is used in the urban coastal areas of California (DWR, 1997). In southern California, about 30 percent of this use goes directly to outdoor urban landscaping and does not generate a wastewater flow (MWD, 1996). In hotter inland areas, this percentage can increase to more than 60 percent (DWR, 1997). In coastal areas of the state, the remaining urban uses (indoor residential, commercial, industrial, and institutional) result in more than 2 million acre-feet of wastewater being treated and discharged annually (BARWRP, 1997). Recycling of any portion of this water constitutes a new water supply — a water supply that can be allocated to other beneficial uses.

By 2020, coastal areas' wastewater flows are expected to increase to over 3 million acre-feet annually. Even considering significant levels of future urban water conservation, this can provide substantial opportunities for water recycling and help achieve CALFED Program objectives for water supply reliability. Recycling creates a unique contribution to improved reliability by providing an additional source of water that is local rather than imported. Further, this source can be relatively resistant to drought, making it available when it is needed most. Perhaps most important, recycling often provides increased water for one beneficial use without reducing the water available for other beneficial uses. From a Bay-Delta perspective, recycling projects in export areas increase water supply without increasing Delta exports or reducing Delta outflow. Thus, water recycling projects can simultaneously help meet CALFED Program objectives for water supply reliability and ecosystem restoration by allowing increased export demands to be met without increased fish entrainment at the Delta export pumping plants. In other situations, recycled water may be used directly for environmental restoration purposes.

New Water Supply vs. Total Water Recycling

In the urban coastal regions, recycling of wastewater increases total water supply by providing a new source of water previously "lost" to a saline sink. However, in other regions (and even in minor portions of coastal regions), recycling does not provide additional new water supply because the treated wastewater is already discharged into rivers, streams, and aquifers, and in some cases downstream water users may depend on this flow. It is important to distinguish the new water supply potential from total water recycling because of its value to water supply reliability.

The amount of new water supply generated from recycled water depends on the receiving body of the wastewater discharge, including:

1. rivers and streams,
2. saline water bodies such as the Pacific Ocean or San Francisco Bay, or
3. recharge/evaporation ponds.

When treated wastewater is discharged into rivers or streams it contributes to baseline flows downstream of the discharge point. This water may not be available for recycling without diminishing streamflow and causing impacts that may need to be mitigated with additional flow augmentations from other sources. To use terminology consistent with the analysis of urban and agricultural water conservation in this technical appendix, recycling of this stream discharge would represent a reduction in applied water and contribute to total recycling, but would not constitute a real water savings or a new water supply. (See also the discussion of *Recoverable vs. Irrecoverable Losses* in Section 4 of this technical appendix.)

Many communities in the Sacramento and San Joaquin Valleys fall into this first category. For example, the Sacramento metropolitan area discharges most of its treated wastewater into the Sacramento River, downstream of Sacramento. This water is then assumed as part of the flows available in the Delta. As wastewater flows increase with population growth, the incremental increase in flows may be available as a new water supply to be recycled for use in and around Sacramento. In other valley communities with less secure water supplies, recycling may be a very important way of reducing the ned to obtain new water supplies. However, current California water law is vague as to how to account for the actual effect on receiving waters and the responsibility for any compensatory releases.

The majority of the state's wastewater flow is generated in coastal areas and discharged to saline sinks. Los Angeles, San Diego, and San Francisco are all examples. The recapture and recycling of their wastewater flows could generate a new water supply in the region.

A third type of wastewater discharge is to recharge/evaporation ponds. The cities of Fresno and Bakersfield use this technique. The wastewater generally percolates into the ground at a rate greater than the aquifer can convey it away from the ponds. This sometimes results in a groundwater "mounding" effect under the ponds. Recycling of any water in excess of local groundwater needs may also be available as a new water supply. Yet the ultimate effect to the local hydrology may dictate that this is not always new water.

For purposes of this analysis, evaluation of water recycling potential will be limited to the state's three primary coastal areas, the San Francisco Bay Area, the Central Coast, and southern California. Since the majority of the state's population resides in these areas, excluding the Central Valley areas is not expected to influence estimated recycling potential significantly.

Understanding Water Recycling Opportunities

Water recycling is gaining in recognition as a viable supply source. More and more urban water agencies are analyzing and implementing water recycling projects for several different reasons, depending on their local conditions. Current drivers include:

- increasingly stringent waste discharge requirements, which affect the timing and quantity of wastewater discharge as well as the type and level of treatment required prior to discharge (an example may include the California Toxics Rule, if implemented similar to other states, it could favor more recycling),
- a need to secure more reliable sources of water to meet growing populations as other new supply alternatives become increasingly more difficult to find or implement,
- a need to offset physical or legislated reductions in some existing surface and groundwater sources,
- in some instances, the local public policy dictates that it is the appropriate action to take to help protect the environment and local resources.
- State Water Code provisions that define use of potable water for nonpotable purposes as a waste and unreasonable use.

However, the potential for water recycling is currently limited by many impediments such as insufficient funding and the high cost of recycling, inter-jurisdictional issues (e.g., rights to wastewater resources), public acceptance of recycled water, and complex permitting and regulatory compliance processes that my be discouraging to some local agencies.

One of the more daunting impediments to water recycling noted by urban water agencies has been cost. The CALFED Program approach to water use efficiency (see Section 2) is based on cost-effectiveness. The CALFED Program proposes to encourage local water suppliers to analyze all options for reducing the mismatch between supply and demand. Further, through the actions detailed in Section 2, CALFED agencies will help water suppliers implement appropriate options starting with the least expensive. This is anticipated to result in identification of feasible recycling projects.

In the past, many agencies have found that there are several options for meeting demand that are less expensive than water recycling. This is supported by findings of the Bureau of Reclamation *Least-Cost CVP Yield Increase Plan* (DOI, 1995). When water transfers are available as a source, they often provide the least expensive increment of additional water supply. Careful avoidance or mitigation of third party impacts associated with water transfers can add to the cost, but transfers may still be a least-cost alternative. It should be noted, though, that many transfers are conducted on a year-to-year basis, while water recycling provides a long-term supply. For many agencies, water conservation measures also can be and have been implemented at a lower unit cost than recycling (see urban conservation costs outlined in Section 5). Despite the extensive implementation of conservation measures that has occurred over the last decade, this technical appendix states that the potential for additional water conservation in the urban sector remains substantial — over 2.2 MAF.

Thus, recycling projects are usually evaluated only in comparison to new supply development. The drivers listed previously as well as the shrinking opportunities for additional supply projects (with their impacts and the need to avoid or mitigate these impacts), are driving up the cost of new supply projects and making recycling more competitive. Still, there are several factors that can make new supply development more attractive to local water suppliers. In the past, many new supply projects have been planned, financed, and built by regional, state, or federal agencies so local suppliers are relieved of the initial burdens of project development (though local agencies may pay this back overtime through contractual arrangements). Water recycling projects improve local water supply reliability and help meet CALFED Program objectives. It may be appropriate for CALFED agencies to assume a planning and financing assistance role for recycling projects, much as they have done for traditional water supply development.

Impediments to water recycling also make it very difficult to project future levels of recycling. In particular, the inter-jurisdictional nature of water recycling makes projections complex and difficult. For example, one agency may secure raw water supplies for a region and deliver water to customers, while another agency may treat wastewater; who is responsible for any recycled water? Water supply from a recycled project may need to move across agency boundaries. In addition, recycled water supplies in an area may be greater than demand in that area, producing water that must be conveyed to another area if customers can be identified. Again, crossing agency boundaries and inter-jurisdictional cooperation would be imperative to achieving significantly increased levels of water recycling.

Other impediments to water recycling include public and market perceptions. Examples of this include public concern regarding the safeguard of potable supplies and perceptions that recycled water could adversely affect the quality of current water supplies. In addition, some agricultural commodity buyers have disallowed the use of recycled water on certain crops, primarily because of concerns about public perception of the end product. Many of these perceptions are inadvertently supported by Department of Health Services' rules regarding where and how recycled water can be used, though these are undergoing change and adaptation. Overcoming these public perceptions is a necessary prerequisite to achieve the ultimate water recycling potential. Public education is an important effort where CALFED can assist.

Impediments to the implementation of recycling projects may require vigorous efforts of CALFED agencies to make these projects feasible. The water recycling assistance programs of CALFED and the CALFED agencies will require much additional refinement and input from stakeholders to maximize program effectiveness. Only through additional innovation and assistance will California be able to realize a significant increase in the use of recycled water.

Determining Water Recycling Potential

Water recycling is and will continue to be an important element of California's water management approach. To emphasize this importance, the legislature, in 1991, adopted goals for the beneficial use of recycled water to include achieving 700,000 acre-foot per year of recycling by the year 2000, and 1 million acre-feet per year by 2010 (Cal. Water Code Section 13142.5 [e]). Currently, just under 500,000 acre-feet of urban water recycling occurs or is under construction in the state, with more projects being completed over the next several years (DWR, 1997).

Regional Water Recycling Studies

About 2.1 million acre-feet of treated wastewater is discharged by urban California into the Pacific Ocean and San Francisco Bay (BARWRP, 1997). As populations continue to increase, the amount of discharge will also rise, potentially reaching more than 3 million acre-feet by 2020. As identified in Section 2 under the Water Recycling Approach *Action 4*, the CALFED Program seeks to identify and encourage regional water recycling opportunities that maximize reuse at minimum cost.

Currently, two regional water recycling studies are underway. The Bay Area Regional Water Recycling Program (BARWRP) previously referred to as the Central California Regional Water Recycling Project(CCRWRP), is in its second phase of feasibility analysis. The Southern California Comprehensive Water Reclamation and Reuse Study (SCCWRRS) is also in its second phase of feasibility analysis, to identify means of maximizing use of recycled water in Southern California. The goal of these studies is to identify regional recycling systems and develop potential capital projects through comprehensive planning processes.

Since both programs are in early stages, clear estimates of water recycling potential are not yet fully available. Also unknown is the overlap that may exist between the regional recycling potentials and the values portrayed in survey results and other data (supplied later in this section). These projects will provide valuable insight into the future potential of recycling when they are complete. But for now, use of regional data for this analysis is limited to the projections of future wastewater flow generated by the anticipated populations in 2020 and existing (or soon to be completed) levels of local recycling.

The Bay Area Regional Study

The Bay Area regional program has estimated that the wastewater treatment entities in the Bay Area, as a result of 1.4 million acre-feet of demand and a population of nearly 7 million, will be generating more than 725,000 acre-feet of water a year by 2020 (CCRWRP, 1995). Accounting for necessary minimum flows to the Bay, 650,000 of that is thought to be available for recycling. The Bay Area regional program has estimated that their existing local reuse by the year 2020 will be 200,000 acre-feet annually. Subtracted from the 650,000, there remains 450,000 acre-feet of wastewater flow available for additional recycling. The regional program is investigating what customers exist for use of this water and how best to treat and distribute it to meet those needs. Considerations of treatment technologies, discharge standards, demands, and various other factors will dictate what percentage of the total wastewater flow generated is ultimately recycled.

The Southern California Regional Study

Though yet to determine a potential customer demand, the SCCWRRS has estimated that 2.4 million acre-feet of treated wastewater would be available for recycling by 2010. By 2040, the estimate increases to 3.1 million annually. For 2020, the estimate may be around 2.6 million (based on linear interpolation by CALFED staff). Estimates of the existing level of water recycling are around 300,000 acre-feet annually. Roughly 2.3 million acre-feet of additional treated wastewater could ultimately receive further treatment and be recycled in 2020.

Total Potential Treated Wastewater Flow Projected by the Regional Studies

Combined, the Bay Area and Southern California regional studies indicate about 3.3 million acre-feet of wastewater being generated by 2020, not including any additional increment that would occur along the central coast (Monterey Bay area and Santa Barbara, though these are minor in comparison to the major population centers).

The approximately 500,000 acre-feet currently or soon to be recycled in California represents about 15 percent of the future treated wastewater stream. With additional projects in the feasibility and design phases, even more facilities are expected to be completed in the near future.

Projected Water Recycling Under the No Action Alternative

To determine the effect of any incremental improvements in recycling as a result of a Bay-Delta solution, it is necessary to determine what level of recycling may occur in the future without a Bay-Delta solution. The CALFED Program No Action condition presented here represents that estimate. Several assumptions used to develop this estimate are detailed in the following paragraphs.

Supply/Demand Constraints on Potential No Action Levels

The No Action estimate presented later in this section reflects a significant level of water recycling occurring in 2020. Current levels of recycling (500,000 acre-feet) would increase to an estimated 1.4 million acre-feet, representing an increase from about 15 percent to 40 percent of the total wastewater flow (see discussion later). To make use of this recycled supply, however, there must be a demand. Customers must be available that can integrate the water in with existing water sources, use it to replace existing sources, or use it as an entirely new source.

As shown in Table 6.1, customers of existing water recycling projects vary. However, the majority of current customers use the recycled water to meet plant evapotranspiration requirements (either crop or landscape). Groundwater recharge represents the next most significant customer use. Use of recycled water by industry or for environmental uses has been limited, but could represent significant potential, depending on the quality and timing of the available supply.

Table 6.1 - Customers of Existing Water Recycling Projects

Type of Recycling	1997 Amount (1,000 acre-feet per year)	Percent of Total
Agricultural Irrigation	155	32
Landscape Irrigation	82	17
Groundwater Recharge	131	22
Industrial Uses	34	7
Environmental Uses	15	3
Sea Water Intrusion Barrier	5	1
Other	63	13
Total	485	100

Source: DWR's California Water Plan Update, Bulletin 160-98, Public Review Draft, January 1998.

Timing of when recycled water is available to meet a customer's demand is probably the most crucial limitation to the amount of recycling ultimately realized. For current agricultural and landscape irrigation uses, the demand is cyclical, peaking in the summer months but minimal in the winter. The magnitude of variation in the cycle depends upon local conditions, such as climate and the type of plants (i.e., agricultural plants are harvested at the end of a season, landscape plants still may need some irrigation during winter months). However, recycled water is generated on a relatively consistent basis, with very little seasonal fluctuation in the amount available. Thus, matching supply to demand can be limited by the type of demand. Strategies to overcome this include finding users whose demdand is not seasonal, on a local or regional level, and storing recycled water for later use.

Figure 6.1 generally illustrates how recycling treated wastewater provides a relatively constant supply source, while some customer demands, such as agricultural irrigation, are more cyclical. This timing mis-match limits the amount of recycled water that can be used by seasonal customers without a method to store supplies during non-peak periods.

The increased use of groundwater recharge to temporarily store recycled water, or in some southern California projects, to act as a barrier to sea water intrusion, provides added flexibility to manage the relatively constant supply and meet seasonal customer demands.

Also, total water recycling levels are limited by the availability of customers within a particular geographic region. As a project looks for customers further away from the treatment plant, the cost of distribution can increase significantly. Lacking regional distribution facilities, agencies generating recycled water must look locally for customers. This can greatly limit the potential opportunities. Industrial and environmental uses can broaden the customer base.

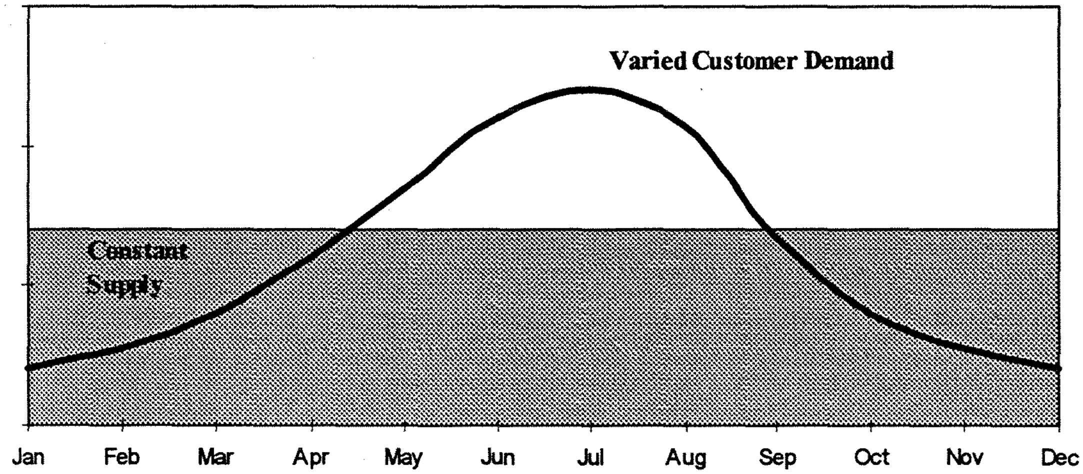


Figure 6.1 - Supply/Demand Timing Difference
Note that only a portion of the water recycled can directly meet this customer's needs. The remainder must be stored or used by customers with a different demand pattern.

Storing water in aquifers can also be limited in its ultimate applicability, depending on its purpose. If the water is being stored temporarily for later withdrawal and use, these limitations include:

- recharge rates are limited by aquifer characteristics and recharge pond or injection well capacity,
- locations for recharge ponds may be limited in heavily populated areas, and
- future additional storage potential in existing aquifers may be limited either as a result of storage already being used for recycled water or being used to temporarily store other surface sources.

If the water is being placed into aquifers as a barrier to sea water intrusion, as is occurring with some recycling projects, these limitations may not be of as much concern. When recycled water is used as a barrier to salty water, it is not primarily intended to be removed and reused. It can continue to "push" more fresh water toward the ocean, increasing the thickness of the barrier. However, there may be a practical limit to how far or how much of a barrier is necessary compared to the cost of providing a barrier. Thus, a practical consideration may constrain this use of recycled water.

Surface storage of recycled water has yet to occur at any significant level. A project being developed in San Diego will be the first to treat a significant quantity of wastewater and recycle it into San Diego's drinking water reservoir. There, the recycled water will blend with other untreated water and be conveyed to the water treatment facility and into the potable system. This project will recycle approximately 15,000 acre-feet. This is referred to as indirect potable reuse. Direct potable reuse is currently prohibited by State regulation. Other indirect potable ureuse sites are under consideration in the BARWRP and SCCWRRS.

Use of other surface facilities to temporarily store recycled water will be limited by the capacity of the reservoirs and the distance from the recycling plant (i.e., reservoir sites may be distant and upslope from a treatment plant such that pumping the recycled water to the reservoir is very costly).

Lacking adequate storage or a distribution system which would allow a more diverse, widely distributed customer base to be included, the potential for water recycling may reach an upper limit of feasibility. For of this analysis, the No Action levels discussed below are assumed to be that practical upper limit (e.g., 1.4 million acre-feet of total water recycling in 2020).

Available Data for Use in Estimating the No Action Level

As previously discussed in Section 2 of this Technical Appendix, under the *Water Recycling Approach,* the California Department of Water Resources, in partnership with the WateReuse Association of California, conducted a *Survey of Water Recycling Potential* in 1995-6 to help identify and quantify local agencies' plans for future water recycling (DWR, 1996). The survey, with 230 respondents, identified 1996 water recycling levels at nearly 350,000 acre-feet per year, and projected the potential for recycling at 1.48 million acre-feet annually by 2020. The respondents listed projects by stages of planning: *conceptual, feasibility study, preliminary design, final design, and under construction*. "Base" conditions include any current recycling projects (projects already in operation) plus all projects that were under construction at the time of the survey. By the end of 1997, with the recent completion of a few more local recycling projects, the base was increased to 485,000 acre-feet (from 350,000 acre-feet). Greater production from existing projects as well as completion of other projects still under construction are expected to increase the "base" to around 615,000 acre-feet by 2020 (DWR, 1997). Further refinement and incorporation of this survey data was completed for use by DWR in the *California Water Plan Update, Bulletin 160-98 Public Draft*. This refinement resulted in the following assumptions for use in this analysis:

- 615,000 acre-feet of total water recycling is the "Base" condition for 2020;
- 468,000 acre-feet of this total is considered new water supply;
- the total represents approximately 18 percent of the 2020 wastewater flow generated.

Data from the survey regarding potential water recycling projects above the base was distributed over three hydrologic regions as either "Planned" or "Conceptual" projects. "Planned" values indicate any recycling projects that are undergoing feasibility study, preliminary design, or final design. Conceptual values reflect what survey respondents believed to be feasible in the future, but no formal studies have been undertaken. Table 6.2 presents the survey information as incorporated into DWR data for use in the *California Water Plan Update, Bulletin 160-98 Public Draft* (DWR, 1998).

Table 6.2 - Cumulative Estimates of Water Recycling in 2020 (1,000 acre-feet per year)

	Total Water Recycling Potential				New Water Supply			
	San Francisco	Central Coast	South Coast	Total	San Francisco	Central Coast	South Coast	Total
Base	40	44	364	615[1]	35	42	328	468[2]
Planned	101	40	640	837[1]	92	38	569	699
Conceptual	--	--	--	131	--	--	--	31
Total	--	--	--	1,583	--	--	--	1,198

Source: Draft information developed for *California Water Plan Update, Bulletin 160-98 Public Draft* (DWR, 1998)
1. The difference between the total for the three hydrologic regions shown and the total for "Base" or "Planned" recycling projects represents projects in the Central Valley that do not generate new water supply. As previously discussed, Central Valley regions have not been included in this analysis at this time.
2. The difference between the total for the three hydrologic regions shown and the total for "Base" projects represents projects in the North and South Lahontan, and Colorado River hydrologic regions already in service and providing new water supply.

Assumed No Action Water Recycling Potential

Projected levels of urban wastewater recycling under the No Action conditions assume full implementation of the "Base" value as well as full implementation of "Planned" values. Therefore, total No Action potential is derived by adding the "Base" value of 615,000 acre-feet to the "Planned" total water recycling quantity of 837,000. Together, these represent a future potential of approximately 1.4 million acre-feet of total water recycling by 2020. New water generated from this level of recycling is estimated at 1.17 million acre-feet. When compared to the total wastewater flow in 2020 projected by the two regional projects, about 42 percent of the wastewater flow is expected to be recycled.

(It should be noted that the DWR Draft California Water Plan Update, Bulletin 160-98, recently released, includes a lower level of water recycling for the South Coast region than indicated in Table 6.2. According to DWR, other options, including resolution of the Colorado River water supply controversy and CALFED Program solutions would provide more water to this region at less cost than additional levels of water recycling. As a result only about 30 percent of the "Planned" recycling potential shown in Table 6.2 for the South Coast was assumed to be implemented as part of Bulletin 160-98. However, the CALFED Program's No Action conditions do not include resolution of the Colorado River issues nor a CALFED Program solution. Thus, for purposes of this analysis, the entire "Planned" potential shown for the South Coast region in Table 6.2 is included in the No Action level.)

Additional Water Recycling as a Result of the CALFED Program

With identification of a Bay-Delta solution, the CALFED Program would result in implementation of the No Action levels of water recycling, at a minimum. This would generally occur through the actions outlined in Section 2 of this Technical Appendix that would facilitate the implementation of No Action levels, probably attaining the levels earlier than would occur without the Bay-Delta solution. In addition, it is expected that additional urban water recycling could occur as a result of the CALFED Program actions.

However, to allow for greater levels of water recycling to occur, the CALFED Program needs to provide solutions to help resolve the issue of local supply and demand timing and regional distribution to reach a broader customer base. Without these, levels of water recycling could not be expected to increase much beyond projected No Action levels. The extent to which additional recycling occurs under a Bay-Delta solution will be dependent on CALFED helping solve supply/demand timing challenges and other factors such as institutional and political impediments to interjurisdictional projects. CALFED intends to work with local agencies to overcome these potentially limiting factors.

Establishing an Upper Limit of Water Recycling Potential

For purposes of developing an upper limit of recycling potential to help identify potential impacts, it is assumed that the issue of supply and demand timing, and other impediments previously discussed, are solved such that their remaining presence does not impede the implementation of cost-effective water recycling projects. Thus, increased levels of water recycling beyond No Action levels are possible. Given this assumption, the extent of future levels becomes dependent on the future wastewater flow present in 2020 and any remaining factors that can limit increased implementation.

Since a Bay-Delta solution also expects to result in extensive urban conservation beyond No Action levels of conservation, it can be expected that the wastewater flow generated in 2020 will be decreased comparably as a result. The level of reduction, however, will depend on which conservation measures are implemented and to what extent.

For this analysis, the increment of urban conservation expected to result from a Bay-Delta solution is assumed to reduce wastewater flows by 7.5 percent from the anticipated 2020 No Action level (the CALFED increment of urban conservation was projected at 5 to 10 percent, with a significant portion obtained through indoor residential, commercial, industrial, and institutional conservation, see Section 5). Therefore, the previous estimates of a total wastewater flow of 725,000 acre-feet in the Bay Area and 2.6 million acre-feet in the South Coast will be reduced to 670,000 and 2.4 million acre-feet respectively; or about 3.1 million acre-feet combined.

Of this total wastewater flow, the No Action condition is expected to already have resulted in about 1.4 million acre-feet of water recycling annually (though this also may be reduced slightly due to increased urban water conservation expected to occur under the No Action condition). Subtracting this from the total wastewater flow potential leaves about 1.7 million acre-feet of treated wastewater still being discharged to the ocean.

It is impossible to say whether water recycling projects could ever be implemented to achieve 100 percent recycling, but it is unlikely that such would occur. Many factors work against this, including:

- the distance between potential customers and water recycling sources,
- physical restrictions of existing treatment plants (space, inflow capacity),
- the limitation of storage
- infeasible cost or technology limitations, or
- other impediments, such as public or market perceptions, local laws or ordinances, a bias in favor of new supply development over recycling, and other institutional and policy challenges.

Even assuming that the issue of supply/demand timing is addressed, these factors are still likely to limit the incremental recycling of the remaining 1.7 million acre-feet.

Considering the factors listed above, this analysis assumes, based on professional judgement, that a maximum of 40 percent of the remaining 2020 wastewater flow could realistically be recycled. Forty percent of 1.7 million acre-feet is about 680,000 acre-feet annually. When combined with the No Action level of 1.4 million acre-feet, the expected level of total water recycling would be just over 2 million acre-feet annually. This would represent an upper limit of total water recycling of about 65 percent, or 2/3, of the total 2020 wastewater flow. Additional indirect potable reuse, direct potable reuse, expansion of treatment plants, and technological advances could all eventually drive the level of recycling up even further.

It is assumed that, based on the No Action values, the new water supply generated from this additional increment of total water recycling is about 550,000 acre-feet annually (80 percent of 680,000 acre-feet). This would be new water available for allocation to other beneficial uses. Table 6.3 shows how these quantities may be distributed among the three hydrologic regions, using No Action values as a basis.

To allow for this level of total water recycling, the various impediments listed directly above and at the beginning of this section, as well as the supply/demand timing issue must all be adequately resolved. Otherwise, the CALFED Program would only result in facilitated implementation of levels equivalent to those discussed under No Action.

As a result, a broad range of water recycling potential is expected for the CALFED Program increment; from zero additional recycling up to 680,000 acre-feet; or in terms of a percentage of the total wastewater flow, roughly from 45 percent to 65 percent.

Summary of Statewide Water Recycling Potential

The table below provides a summary of the potential water recycling estimated to occur both under the No Action and CALFED Program conditions. The upper end of the CALFED Program incremental range represents an additional 20 percent of all wastewater flows being recycled. The lower end of the range represents no marked improvement over the No Action condition, or about 45 percent of the total wastewater flow being recycled. This could occur if the impediments to move beyond No Action levels are not adequately addressed (i.e., storage and regional distribution). The combined total water recycling potential represents an upper range of 65 percent recycling of the total 2020 wastewater flows.

Table 6.3 - Summary of Incremental Statewide 2020 Water Recycling Potential

	No Action Increment (1,000 acre-feet annually)		CALFED Program Increment (1,000 acre-feet annually)	
	Total Water Recycling	New Water Supply	Total Water Recycling	New Water Supply
San Francisco	140	125	0 - 110[2]	0 - 90[2]
Central Coast	85	80	0 - 45[2]	0 - 35[2]
South Coast	1,000	900	0 - 525[2]	0 - 425[2]
Total	1,400[1]	1,170[1]	0 - 680	0 - 550
Combined Water Recycling Potential (No Action + CALFED)			1,400 - 2,080	1,170 - 1,720

1. The three hydrologic region values do not add up to the total because of recycling that occurs in other areas of the state as part of the "Base" condition (see Table 6.2).
2. These regional values were prorated from the total based on the distribution of the No Action regional values (e.g., for the No Action increment, the South Coast represents about 77% of the total new water supply. Therefore, the South Coast's CALFED increment is assumed to be 77% of the CALFED increment total).

7. The Water Transfer Element

The CALFED Program recognizes that water transfers are an important part of the California water management landscape and are valuable in the effort to improve water supply reliability, water use efficiency, water quality and the aquatic ecosystem. Transfers can provide an effective means of moving water between users on a voluntary and compensated basis, as well as a means of providing incentives for water users to implement management practices which will improve water use efficiency. Transfers can also provide water for environmental purposes in addition to the minimum instream flow requirements.

The CALFED water transfer element will propose a policy framework for water transfer rules, baseline data collection, public disclosure, and analysis and monitoring of water transfers, both short and long-term. The element, in its final form, may also identify areas where additional regulation or statutory changes are desirable.

The goals of this policy framework are those that have been established for the Program:

- to reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system;

- to improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species; and

- to provide good water quality for all beneficial uses.

A prominent feature of each draft CALFED alternative is modification of Delta water conveyance, ranging from modest changes in operations to major physical changes in Delta configuration. These changes in the Delta would, to varying extent, address the need for adequate flexibility and capacity in Delta conveyance facilities so that transfers can be accomplished without impairment of the delivery of Central Valley Project and State Water Project water supplies.

However, the *capacity* to transfer water differs from the *policy framework* necessary to allow water transfers to successfully occur. The water transfer element focuses on providing this framework. Additional information regarding the conveyance capacity under existing conditions is contained in a paper entitled *Water Transfers in Context of the CALFED Bay-Delta Program*. This paper is presented as a supplement at the end of this section.

State and Federal Water Transfer Policies

Both State and federal law contain provisions that authorize, acknowledge, or support water transfers. In the past five years, important policy on water transfers has been established or reaffirmed at both the State and federal levels.

CALFED recognizes that water transfers can have adverse as well as beneficial impacts. CALFED actions to reduce conveyance constraints or to facilitate cross-Delta transfers could potentially exacerbate adverse impacts associated with water transfers. In order to minimize or mitigate the adverse impacts of water transfers, the CALFED Water Transfer Element will be guided by the five criteria articulated by the Governor in his 1992 water policy statement.

In his water policy speech in April of 1992, Governor Wilson reiterated the State's support for use of water transfers and the water transfer market, and described five criteria which transfers must meet:

> First: Water transfers must be voluntary. And they must result in transfers that are real, not just paper. Above all, water rights of sellers must not be impaired.
>
> Second: Water transfers must not harm fish and wildlife resources and their habitats.
>
> Third: We need to assure that transfers will not cause overdraft or degradation of groundwater basins.
>
> Fourth: Entities receiving transferred water should be required to show that they are making efficient use of existing water supplies, including carrying out urban Best Management Plans or Agricultural Water Efficiency Practices.
>
> Fifth and finally: Water districts and agencies that hold water rights or contracts to transferred water must have a strong role in determining what is done. The impact on the fiscal integrity of the districts and on the economy of small agricultural communities in the San Joaquin Valley can't be ignored . . . any more than can the needs of high value-added, high tech industries in the Silicon Valley.

In addition to the Governor's policy, both California law and federal law include provisions that authorize and acknowledge transfers as reasonable and beneficial uses of water. California Water Code section 109 says in part: "It is hereby declared to be the established policy of this state to facilitate the voluntary transfers of water and water rights ...".

The 1992 Central Valley Project Improvement Act also addressed transfers. Section 3405(a) of the CVPIA authorizes all individuals or districts who receive Central Valley Project (CVP) water under water service, repayment, water rights settlement or exchange contracts to transfer all or a portion of the CVP water they receive to any other California water user.

However, even with this policy framework and a significant body of statutory law on transfers, there are a number of issues and questions which continue to arise and CALFED has been encouraged to address these issues and questions in the long term Bay Delta Program.

BDAC Policy Review

The question of how the CALFED Program should approach water transfer issues was presented to BDAC for policy advice. BDAC concurred that water transfers are an appropriate and useful part of the CALFED water management strategy. Individual BDAC members also expressed the view that the CALFED program should consider several water transfer issues, including third party impacts, protection of water rights, and the proper roles of water rights holders and water users in the review and approval process for transfers.

Objectives of the Water Transfer Element

In addition to CALFED goals listed above, there are objectives specific to the Water Transfer Element:

1. Promote, encourage and facilitate water transfers, within the framework of the Governor's water policy.

2. Address the institutional, regulatory and assurance issues which need to be resolved to provide for a more effective water transfer system.

3. Address the physical issues which need to be resolved to provide for a more effective water transfer system, and particularly cross-Delta transfers.

4. Encourage transfers that result in net improvements for water supply reliability.

5. Encourage transfers that result in net improvements for ecosystem health.

6. Encourage transfers that result in net improvement for water quality.

7. Encourage the development of a water transfer system that avoids adverse impacts where possible and that adequately mitigates unavoidable adverse impacts.

8. Promote and encourage uniform rules for transfers using state and federal project facilities and cross Delta conveyance capacity.

9. Promote and encourage the development of standardized rules for transfers based on replacement with groundwater and other conjunctive use type transfers, so that water transfers do not cause degradation of groundwater basins and long-term groundwater levels are sustained or improved.

10. Identify and resolve Delta carriage water and reservoir refill criteria issues.

Issues to Resolve in Developing an Effective Water Market

A number of issues related to water transfers have been identified through the CALFED public process. Some of these issues are questions of legal interpretation; some are political or policy based; some are administrative or technical. Some issues exist because of misunderstanding or lack of understanding about how the current water transfer system operates.

The successful implementation of some of the components and elements of the CALFED Bay Delta program depends on the existence of a rational, well regulated statewide water market. The CALFED water transfer element can be used to identify and resolve issues which have impaired the development of a more efficient water transfer market or which will allow the other CALFED Program components to function more effectively.

Issues identified thus far in the process are listed below.

1. *Uncertainty about what constitutes transferable water* - There are a number of variations or corollaries to the question of "what constitutes transferable water?"

   a. What constitutes transferable water for a transfer of saved or conserved water? For a fallowing or crop shift transfer?
   b. Can water quality improvements or changes in flow timing be used as a measure of transferable water?
   c. What is the significance for transferability of the distinction between water held under water right and water held under settlement contract? A related question is what are the rules for determining who's water right is being transferred?
   d. Does the current water transfer system encourage consumptive use of water which would not otherwise occur?

2. *Regulatory process problems and permit streamlining* - Are there any changes or improvements to the water transfer permit process, either by transfer proponents or by the agencies that would result in more timely processing?

3. *Accounting and tracking of instream transfers* - How can water transferred under a Water Code section 1707 permit be tracked and accounted for?

4. *Priority of access to project facilities for transferred water* - What are the rules for priority of access to CVP and SWP facilities for conveyance or storage of transferrable water? How can the existing CVP and SWP facilities provide reliable conveyance through the Delta for transferred water, without impairing CVP and SWP contractual obligations? This relates to carriage water and reservoir refill criteria, also.

5. *Carriage water requirements in the Delta* - When are cross-Delta transfers subject to carriage water requirements? How are these determined and by whom? When does the export/inflow ratio apply to transfers?

6. *Reservoir refill criteria* - What are the rules for reservoir refill in connection with a transfer of stored water? Who determines these?

7. *Protection of Groundwater Resources* - What should be CALFED Program's policy regarding transfers of groundwater and surface water transfers with groundwater replacement? What policy, rules or criteria are needed to protect local groundwater resources from impairment as a result of these kinds of transfers?

8. *Protection of environmental values* - What rules and criteria would ensure that environmental impacts of proposed transfers will be critically evaluated, and avoided or mitigated?

9. *The nature, extent and ability to mitigate third party impacts* - How will CALFED address the need for mitigation of third party impacts of transfers? What is the role of local agencies?

10. *User vs District initiated transfers and local control* - Who has the authority to sell water when the District holds the right or the contract? When the user holds the right, what is the role of the local agency?

11. *Water rights and area of origin protection* - Do upstream water rights and "area of origin" priorities need additional protections to avoid impacts from water transfers? If so, what?

12. *Assumptions about transfers and capacity of new facilities* - Should any assumptions be made about water transfers in sizing new facilities? What assumptions should be made about water transfers when calculating water supply results of new facilities?

13. *Interpretation of the "no injury" rule and the distinctions among types of adverse impacts* - How is "injury" defined? Are there different types of injury (e.g., significant, avoidable, acceptable)?

BDAC and CALFED Agency Involvement

The Bay Delta Advisory Council (BDAC) formed a Work Group to consider the policy issues related to transfers and the appropriate role of CALFED in developing a water policy/water market framework. Several of the issues identified in this paper have become the subject of discussion by the Work Group. The Work Group may identify other issues which will also need to be considered.

Some of the issues identified here can probably be resolved at the CALFED agency or staff level, particularly those which are more technical in nature. Representatives of CALFED agencies are working together to help define and resolve these issues. The agency committee has provided background and technical information to the BDAC Work Group on some of the issues.

The CALFED Program intends to continue to work with through both of these representative groups in order to find solutions to the multitude of complex water transfer issues. It is assumed that these two groups will continue to work on solution options as the draft Programmatic EIR/EIS is reviewed.

Solutions Options for Third-Party Impact and Groundwater Use Issues Offered by the BDAC Work Group

At the first BDAC Water Transfer Work Group meeting, participants identified third party impacts and groundwater resource protection as priority issues for considerations. CALFED staff proposed a process which would allow the BDAC work group to focus its efforts on developing solution options and provide policy recommendations to BDAC and the CALFED Program regarding these issues. CALFED Program staff developed discussion papers on these two issues to help facilitate understanding of the issue and development of solution options. These discussions follow. Among all the water transfer issues identified, providing adequate assurance of the avoidance or mitigation of impacts on groundwater resources and third parties will be the most critical issue for CALFED to resolve.

Protection of Groundwater Resources

Issue/Question: What should be the CALFED Program policy regarding transfers of groundwater and surface water transfers with groundwater replacement? What policy, rules or criteria are needed to protect local groundwater resources from potential impairment resulting from such transfers?

Background: There are essentially two types of groundwater transfers: direct groundwater transfers (where groundwater is pumped into a conveyance system and transferred) and groundwater substitution transfers (where surface water is transferred and replaced with pumped groundwater).

The general legal rule is that only groundwater which is surplus to the needs of the overlying landowners can be transferred for use on non-overlying lands. (But does this refer to "surplus" in real time, say the immediate water year, or it does mean "surplus" over some longer period of time, allowing for periods of groundwater recharge?) Groundwater generally cannot be transferred from a basin in a condition of overdraft. Note that these rules apply to direct groundwater transfers but do not apply to groundwater substitution transfer where the groundwater is used on overlying lands.

Water Code Section 1220 prohibits groundwater export from the Sacramento or Delta-Central Sierra Basins (as defined in Bulletin 160-74, this appears to include the entire Sacramento Valley and the San Joaquin Valley roughly north of the Stanislaus River), unless the groundwater pumping is in compliance with a groundwater management plan adopted by county ordinance in consultation with affected water districts, and subsequently approved by a vote in the counties or portions of counties that overlie the groundwater basin. It is not clear whether groundwater can be purchased for instream flow purposes within the specified basins. (Is this an export?)

Regarding groundwater substitution transfers, Water Code Section 1745.10 says "replacement pumping" is not permitted unless it is consistent with a groundwater management plan for that area or the water supplier determines there will no be long term overdraft impact. (This section is part of Article 4, Chapter 10.5, Part 2 of the Water Code and applies only to transfers of water by a "water supplier", as defined, or an individual water user who receives water from a "water supplier", so it may not apply to all groundwater substitution transfers).

Section 1745.11 also has application to any discussion of Article 4 transfers (Section 1745 ET seq.). This section provides that nothing in [Article 4] "prohibits the transfer of previously recharged groundwater or the replacement of transferred surface water with groundwater previously recharged into an over-drafted groundwater basin, if the recharge was part of a groundwater banking operation carried out by direct recharge, by delivery of surface water in lieu of groundwater pumping, or by other means, for storage and extraction."

A provision of the CVPIA requires that a determination be made that transfers of CVP water will have no long term adverse impact on groundwater conditions in the transferor's service area.

The State Board has no jurisdiction over groundwater transfers but does have authority to prohibit "waste or unreasonable use" of groundwater. Presumably the "no injury" and "no unreasonable impact" rules are applicable to transfers of groundwater and enforceable by legal action. Also, any long term transfer would require CEQA documentation which would include analysis of impacts on groundwater.

Several Sacramento Valley counties have passed ordinances restricting or limiting the export of groundwater. Similar ordinances have been considered by some San Joaquin Valley counties.

Several groundwater basins (probably 14, mostly in southern California) have been adjudicated, in which case the adjudication controls groundwater pumping and transfers.

Also, Water Code section 10750 (AB 3030) authorizes public agencies and mutual water companies to develop groundwater management plans for their service areas.

Discussion: Most transfers involving groundwater have been groundwater substitution transfers. In the San Joaquin Valley there have been some cases of groundwater exchanges, where groundwater is pumped into a conveyance system in exchange for use of surface water elsewhere on the system either concurrently or at a later time.

Ground water transfers or surface water transfers based on groundwater substitution, unless properly regulated, could result in adverse impacts to groundwater resources, with significant adverse environmental and economic effects, in the source water area. Such impacts might include land subsidence, lower groundwater levels and higher pumping costs, degradation of groundwater quality, impacts to vegetation dependant on groundwater, or in extreme cases, losses of existing wells. The potential for adverse impacts to groundwater resources makes transfers politically sensitive in source water areas, such as the Sacramento Valley.

Currently, there is no mechanism in state law for watershed based management of groundwater resources. This may lead to inconsistent approaches to groundwater management by local agencies, with adverse effects on the development of a statewide water transfer market. The absence of any mechanism for watershed based groundwater management makes it more difficult to develop conjunctive use programs and other tools for more effectively managing groundwater and surface water.

There are several specific issues presented by groundwater based transfers. First, when and subject to what conditions can groundwater be directly transferred and exported out of the basin? (A corollary question is whether the rules are or should be different for in-basin groundwater transfers?) What impacts should be considered - water quality, pumping levels, short term overdraft, long term overdraft, impact on surface flows, others? Are there circumstances in which transferred groundwater can be replaced with surface water which becomes available later in the year and used for irrigation or recharge?

Second, when can transferred surface water be replaced with groundwater? Can replacement be done concurrently with the period of the transfer or can the water be pumped later in the year? Most groundwater substitution transfers result in no change in the cropping or irrigation patterns that would have occurred with the use of surface water. In some cases, a water user may want to transfer surface water in the spring or summer, and then pump groundwater to replace some or all of the surface water later in the year for a different crop than would have been grown with the surface water. Should there be limits on these types of transfer to protect the local groundwater resource from overdraft and to protect other overlying users of the groundwater from the increased costs of pumping groundwater from deeper levels than would have occurred in the absence of the transfer?

In application of the "no injury" rule to a groundwater substitution transfer, the approving agency must consider whether the groundwater to be pumped satisfies the "real water" test. If the groundwater pumping would directly affect accretion to or depletion from a stream, there may not be any true increase in the water supply and thus, no real water. Also, the potential for injury to a downstream user must be analyzed.

Regarding impacts on CVP and SWP specifically, approving agencies must consider whether a transfer of groundwater or a "groundwater substitution" transfer adversely affects stream flow by inducing a depletion from the stream at a time when the Delta is in balanced conditions, thereby compelling the CVP or SWP to increase reservoir releases to maintain outflow or salinity requirements in the Delta. (Balanced conditions occur when releases from upstream CVP and SWP reservoirs plus unregulated flows approximately equal Sacramento Valley in-basin uses plus exports. Balanced conditions are maintained by regulating the rate of export pumping and/or by storage releases from upstream reservoirs.)

This issue raises a corollary question regarding the extent to which the projects are entitled under existing law to protection from the reasonable and beneficial use of groundwater by overlying owners. In other words, are the projects entitled to continued accretions to stream flow from groundwater sources, as against the overlying owner's lawful consumptive use or transfer? Is the answer different if the overlying use is to replace transferred surface water?

Both the CVP and SWP have also expressed concern in the past about the water quality problems associated with using project facilities to convey groundwater. In some cases, groundwater is of significantly lesser quality than the project's surface water supplies and introduction of groundwater into the system may create drinking water treatment problems.

A major set of issues related to groundwater transfers (and surface water transfers with groundwater substitution) is the impact on other groundwater users in the source water area. These "third party impacts" of groundwater transfers may result in lower groundwater levels, or reduced water quality of the remaining groundwater. (See discussion on Third Party Impacts.)

One common thread among these issues is the need for more complete data and better understanding about the groundwater - surface water interface, particularly in the Sacramento Valley. Improved understanding of this relationship will be essential to developing conjunctive use and banking programs, as well as enabling local water managers to make informed decisions about groundwater based transfers.

Solution Options for Protection of Groundwater Resources:

- Local water management plans (AB 3030) incorporating rules on groundwater transfers.
- Local ordinances to regulate groundwater transfers.
- Analysis and public disclosure of groundwater impacts as part of short term transfer approval process.
- Adjudication of groundwater basins.
- Additional data regarding the Sacramento Valley groundwater basin to enable a better understanding of the relationships between surface water and groundwater and of the recharge capacity of the aquifer (or aquifers).
- A regional entity (perhaps a joint powers agency of Sacramento Valley counties), or separate watershed management entities, to study the groundwater resources of a particular area and to provide technical review and advice to local agencies regarding transfers involving groundwater. (CALFED could provide financial support and/or incentives for such an entity or entities).
- State legislation to more clearly define the limitations on transfers of groundwater or groundwater replacement or to require broader application of local groundwater management plans.
- Other tools to respond to the third party impacts of groundwater based transfers will be discussed under the third party impacts discussion.

The Nature, Extent and Ability to Mitigate Third Party Impacts

Issue/Question: How will CALFED address the need for mitigation of third party impacts of transfers? What is the role of local agencies?

A major set of issues related to water transfers, particularly out of basin, long term (multi year) transfers, is third party impacts. Generally, there are three types of third party impacts: impacts to other legal users of water (usually downstream users); environmental impacts; and economic effects in the source area. This discussion focuses on third party economic impacts of transfers. (Cumulative impacts of a series of one year transfers or multiple long term transfers from the same area raise a special set of third party impact issues. This issue will be discussed in a separate paper.)

Background: Impacts to downstream users are addressed by the "no injury" rule. The "no injury" rule prohibits transfers which would harm another legal user of the water proposed for transfer.

This rule is found at Water Code sections 1706, 1725, 1736 and 1810(d).

The "no injury" rule is the legal mechanism for the prohibition of transfers of "paper water" (water which would not otherwise be consumptively used or does not increase the available water supply).

State law also prohibits transfers which would have an unreasonable impact on fish, wildlife, or other instream uses. See Water Code sections 1025(b), 1725, 1736 and 1810(d). A similar prohibition applies to CVP transfers subject to the CVPIA.

Economic impacts of transfers are less clearly regulated. It is generally recognized that certain types of transfers can have adverse impacts on local economic conditions. Fallowing transfers, for example, will result in lower agricultural production in the source area and may impact local employment of farm workers and others.

Groundwater transfers or transfers of surface water with groundwater replacement may result in lower groundwater levels, lower groundwater quality and higher pumping costs for other local groundwater users. In extreme cases, impacted groundwater users may lose the use of existing wells due to water quality degradation or lower groundwater levels. (Groundwater issues are discussed in more detail in Issue 7 discussion previously. This discussion does include some discussion of the potential impacts of groundwater transfers.)

State law does not generally address the economic impacts of fallowing or groundwater transfers. Section 1810(d) provides that the conveyance facilities of a public agency (state, regional or local) may not be used to transfer water if the transfer would have an "unreasonable effect" on the local economy. The term "unreasonable effect" is not defined.

Section 1745.05(b) of the Water Code limits fallowing transfers by water suppliers to twenty percent of the water that would have been applied or stored by the water supplier, absent the transfer. Water Code Section 1745.10 prohibits replacement of transferred surface water with groundwater unless certain conditions are satisfied, i.e., consistency with local groundwater management program, or a finding of no contribution to long term overdraft of groundwater.

CVPIA prohibits the Secretary of Interior from approving a transfer which would have a long term impact on groundwater conditions or which would unreasonably impact the water supply, operations, or financial condition of the transferor district or its water users.

Water Code sections 1215 and 11460 prohibit transfers which would deprive areas of origin of water reasonably required to meet local beneficial needs.

However, there is no counterpart of general application in state law to the "no injury" rule or the "no unreasonable environmental impact" rule for economic impacts of fallowing or groundwater based transfers.

Discussion: The fundamental policy issue related to economic impacts of transfers is to what extent should external impacts be internalized as transaction costs of the transfers. How should such costs be calculated? Who should decide which costs are part of the transfer cost? Who decides what level of adverse impact is significant or unreasonable? Ultimately, this leads to a debate about who should have the authority to approve, disapprove or condition a proposed transfer?

Generally these questions will arise in transfers based on land fallowing or crop shifting, or in transfers involving increased use or pumping of groundwater. True conservation transfers (reductions in irrecoverable losses) probably do not generate the same level of third party impacts because they do not affect the level of production or economic activity in the source water area.

There is a range of approaches to the question of how to deal with economic impacts of water transfers. At one end of the range is the view that a purely market based approach to water transfers should not concern itself with external economic impacts. A water rights holder or water user is under no legal obligation to provide employment or economic benefits to his/her community. No one would argue that a farmer must farm his/her land every year in such a way as to generate a given level of employment or economic activity in the local area. No one would argue that if a landowner sells a parcel of land, that he or she must compensate others who are affected by the change to the local economy resulting from a change in use of the land. According to this logic, then, a farmer or water supplier who sells the right to use water should have no obligation to constrain his/her action due to adverse economic impacts to others and society should not interfere with the operation of the market.

An alternative view is that water transfers should operate in a more regulated environment, based on the concept that water is not a pure commodity, but is in the nature of a shared natural resource, to which an entire community (or region, watershed or basin) has some claim of right. Water "per se" is legally owned by the people of the state and an individual user has only the right to the use of so much as can be put to reasonable and beneficial use. While transfers are recognized under state and federal law as a reasonable and beneficial use, a pure market approach to water transfers fails to acknowledge that entire communities and local or regional economies rely on the economic value produced by the local use of water. Therefore, changes in purpose or place of use of water which affect local socio-economic conditions must be regulated to avoid or mitigate adverse impacts. While this latter view is probably more widely accepted, it still leaves open a number of questions regarding the scope and kind of protection which should be provided against third party economic impacts.

Third party impacts may also occur when the transfer is a direct groundwater transfer or when surface water is replaced with groundwater and there is no recharge or replacement (conjunctive use) program. Here there is a direct impact on a resource which is legally defined as subject to correlative rights (the right of all overlying users to make reasonable and beneficial use of the groundwater). The use by one directly affects the use by another. If one user is allowed to sell or pump groundwater to the detriment of other overlying users, the correlative right can be impaired or destroyed. As noted above, state law proscribes certain types of groundwater transfers which contribute to groundwater overdraft, but does not address economic impacts.

Solution Options for the Nature, Extent and Ability to Mitigate Third Party Impacts: Over the past few years, a number of mechanisms have been suggested for dealing with the local economic impacts of water transfers. Some of the possible tools or options are:

- an agreed upon definition of "third parties" (who are the parties who have a recognizable impact?)
- limits on the number of acres which can be fallowed (in order to produce transfer water) in a given area (District or county);
- limits on the amount of water which can be transferred from a given area (District, service area, county);
- a tax on transfers to compensate the local area for increased social service costs incurred by local governments;
- a mitigation fund for compensating losses or to pay for retraining farm workers, to be administered by local governments;
- a mitigation or compensation fund for those who incur higher groundwater pumping costs as a result of a transfer;
- further restrictions on groundwater transfers or groundwater substitution (e.g., establish a limit on groundwater level drawdown);
- legislation to define level of acceptable impacts of transfers;
- a central "clearinghouse" to collect and disseminate information on transfers and transfer impacts.

Development of Solution Options through the BDAC Work Group

Following presentations during the BDAC work group meetings of case studies, which provided 'real world' illustrations of water transfer projects and related third party and groundwater resource impact concerns, the group developed a broad range of solution options. The options presented in the issue discussion above were also incorporated. From these, a more refined list of options was generated by CALFED staff and discussed and further refined by the BDAC work group participants. The refinement focused on creating options which participants can support as part of a water transfer policy framework incorporated into the long-term CALFED Bay-Delta Program.

Support for the refined solution options was not and will not be unanimous. Support in some cases must be considered tentative or conditional, depending on other aspects of the policy framework, how the policy is implemented, or other components of the CALFED Program. Nevertheless, the list of solution options below is supported by a significant number of stakeholders in the BDAC work group.

The major themes of the broadly supported solution options are:

- baseline data collection;
- neutral party analysis and monitoring of transfers;
- cumulative impact analysis;
- public disclosure of data and analysis; and
- public participation in the transfer review process.

More specifically, the solution options discussed and supported by the BDAC work group can be described as functions to be performed or managed by an institution or entity as yet undefined. They include:

- Research and development as necessary to establish credible and adequate baseline information on groundwater conditions and groundwater/surface water interaction.
- Extensive groundwater monitoring programs before, during and after specific water transfer projects.
- Development of analytical requirements for specific water transfer projects based on the type of water transfer (e.g., intra-basin, inter-district, change in purpose of use, instream or environmental use, out of basin).
- Adequate, project-specific environmental review and analysis of each water transfer proposal.
- Basin-wide planning goals for surface and groundwater resources.
- Public disclosure of all pertinent information on each water transfer proposal, through a process funded by transfer proponents, and public participation in the review and approval process, including:
    - public notice of proposed water transfer projects;
    - public disclosure of water transfer proposals and plans, explanation of anticipated impacts and mitigation strategies;
    - disclosure and explanation of claims process for parties seeking compensation for damages resulting from water transfers
    - decision making by the transferor in and through the public process; and
    - educational programs for the public regarding water transfer terminology, process and technical information.

The BDAC work group also expressed their strong view that physical limitations on transfers should not be part of the CALFED Program policy framework. This needs to remain a decision made at the local level, provided that the process is adequate to protect local interests from adverse impacts associated with a transfer.

CALFED Program Initial Recommendations

Based on advice to date from the BDAC Water Transfer Work Group and the CALFED agencies, the CALFED Program has develop initial recommendations for a water transfer element that includes four primary features.

First, the CALFED Program acknowledges the necessity of avoiding impacts to local environments, groundwater resources, and community economies, whenever possible, and of providing necessary mitigation where impacts are unavoidable. The CALFED Program is recommending the development of a locally or regionally governed water management process, such as a water transfer information clearinghouse, to ensure adequate data collection, baseline analysis, public disclosure of transfer proposals, public participation in the review process, monitoring of water transfers, and cumulative impact analysis.

Second, where the administrative policies or actions of individual CALFED agencies affect water transfers, the CALFED Program recommends and encourages the CALFED agencies to adopt and implement uniform, integrated rules and criteria for the processing and approval of water transfers, including rules for access to storage and conveyance facilities. Agency rules and criteria should be structured to assure that water transfers produce not only improvements in water supply reliability, but also net improvements in ecosystem health and water quality.

Third, the CALFED Program recognizes the need for adequate flexibility and capacity in Delta channels and conveyance facilities, so that transferred water can be moved across the Delta efficiently and effectively, without interfering or conflicting with ecosystem needs or the delivery of state or federal project water supplies.

Fourth, based on comments and discussion during the Programmatic EIR/EIS review process, the CALFED Program may develop and submit recommendations to forums outside the CALFED process on additional water transfer policy or legislative needs. Such recommendations would relate to the further development of a rational and regulated water transfer market in California and could include protections for water rights, instream flow needs, groundwater levels, and third party economies to help ensure the Governor's policy criteria.

The Clearinghouse Concept

A primary goal of the water transfer element is to address the stakeholder concerns about third party impacts and groundwater protection issues in a way which is consistent with Program objectives and solution principles. Often discussed as a potential mechanism, an "information clearinghouse" would assist the local decision making agencies in analyzing the benefits and adverse impacts of transfers, both short term and long term, project specific and cumulative. It would not require any change in existing regulatory authority or water rights law, but it would provide expertise, resources, advice and recommendations to local agencies and other interested parties, so that decisions could be made with all parties in possession of complete and accurate information. The clearinghouse could potentially expand its role to also function as a market broker, by making information available to interested buyers and sellers about water transfer supply and demand.

The discussion below outlines how a clearinghouse might work in the Sacramento Valley. Presumably, a similar institutional approach might be useful on the San Joaquin system, or in the Delta or other parts of the state.

Possible Functions of a Water Transfers Clearinghouse for the Sacramento Valley

- Collect, develop and analyze baseline data on existing conditions, particularly in terms of groundwater levels and quality, groundwater recharge rates, groundwater - surface water relationships, and streamflow accretion and depletion rates.

- Develop data on range of surface water and groundwater supplies available for transfers, long term and short term, from the Sacramento Valley, and describe source of water, type of transfers, time or periods of availability, etc.

- Make all data available to the public.

- Collect information on proposed transfers of all types involving water from Sacramento Valley watershed (except intra-District transfers).

- Provide public notice on all proposed water transfers and provide a forum (if not otherwise provided) for public discussion and comment on proposed transfers.

- Provide technical analysis on groundwater - surface water interface. Eventually develop a model on the groundwater - surface relationship in the Sacramento Valley.

- Provide advice and assistance to local decision makers on technical analysis, environmental impacts and economic impacts.

- For groundwater transfers, this would include, for example, modeling data on impacts to groundwater or groundwater quality, effects on streamflow accretions and depletion, and estimates of recharge times. For surface water transfers, it might include analysis of water quality impacts and third party economic impacts.
- This could include financial assistance if funds were available.

- Provide cumulative impact analysis of transfers on a stream or watershed basis.

- Provide recommendations to decision makers on ways to avoid, minimize or mitigate environmental or economic impacts.

- Develop and administer monitoring programs to determine impacts of transfers on groundwater conditions, water quality, agricultural production, environmental conditions, etc.

- It is also possible that the clearinghouse functions could be expanded to include those of a market broker for sellers and buyers of water. The clearinghouse could, for example, "post" information about water available for sale for the use of potential buyers, and circulate requests for purchase among potential sellers.

- Alternatively, the clearinghouse could operate as a bank, receiving deposits (sales) of water to be held for withdrawal (purchase). This might also be done with option contracts for water.

- The clearinghouse could also develop a set of priorities or guidelines on transfers which could be used by decision makers. For example, the general outline of a priority scheme might be (a) intra-District transfers, (b) intra-basin transfers, (c) instream transfers, (d) out of basin transfers.

Who Performs These Functions?

- One of the concerns repeatedly expressed by some stakeholders is that DWR and USBR could not function effectively as a clearinghouse due to their obligations to their contractors. While some have expressed reluctance at the idea of increasing the scope of the State Water Resources Control Board jurisdiction, it may be logical for the State Board to assume the responsibility for these functions. This would not necessarily mean any expansion of the Board's water rights authority (although that may logically follow at some point).

- Another possibility is the formation of a joint powers authority of local district and counties in source water areas. (There might be one such authority for the Sacramento Valley, another for the San Joaquin system and a third for the Delta.)

- Another possibility is that the clearinghouse function could be performed by a non-governmental entity, such as the University of California, or a specially formed private, not for profit corporation. Local agencies could contract with this entity for its services.

- Another possibility is that the clearinghouse functions are performed by local agencies, without formation of a new entity or a state agency.

How Does the Transfer Clearinghouse Concept Advance CALFED Objectives?

- The clearinghouse provides baseline data on water supplies available for transfer and the circumstance or conditions under which water can be transferred.

- The clearinghouse provides a "neutral party" to analyze transfer impacts and provide information to public.

- It makes transfers "easier" if the public has more information; this should reduce the level of political distrust.

- As a market broker, it provides a central point for sellers and buyers to obtain information.

How Would the Clearinghouse be Funded?

- Initially, funding would have to be provided by the State, as part of the CALFED program budget.

- At some point, a surcharge could be added to transfers to cover the expense of clearinghouse operations and administration (i.e, buyers or sellers of transferred water would pay).

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Supplement A:

Water Transfers in Context of the CALFED Bay-Delta Program

Supplement A: Water Transfers in Context of the CALFED Bay-Delta Program

At the BDAC Water Transfer Work Group meetings, as well as during other CALFED public discussions, questions have been raised regarding both the physical capacity to transfer water given either existing conditions or CALFED alternatives, and the potential quantity, sources, and destination of transfers. At this stage of analysis of the CALFED alternatives, it is not possible to provide complete answers to these questions. It is possible, however, to provide a general response that may be helpful in providing some context for the discussion of water transfer policy issues, such as third party impacts and groundwater use and protection. The intent of this paper is to:

- Describe the estimated available transfer capacity of the existing system, both physical and constrained by legal and regulatory requirements
- Discuss the potential effects CALFED alternatives may have on available transfer capacity and how this capacity may be estimated using physical models
- Speculate on the demand potential for south-of-Delta water transfers
- Discuss the potential demand for water transfers to meet environmental needs
- Portray the additive or inclusive qualities of the various water transfer demands
- Discuss the use of economic modeling for transfer policy analysis

The information presented below is very general and based on several data sources as well as professional judgment. The information is not exact, but it should help focus the work group effort on resolution of water transfer policy issues that exist regardless of future water transfer quantities or limitations.

Available Transfer Capacity of the Existing System

The existing storage and conveyance system is *physically* limited by the size of channels, pumping plants, and storage reservoirs at various points in the system. For instance, if supply and demand existed and if the State Water Project and Central Valley Project south Delta pumping facilities were to pump at full capacity 365 days a year, the total export could theoretically be as much as 11 million acre-feet per year. Of course this has never occurred, nor is it anticipated to occur because of demand and supply limits, operational logistics, and regulatory and legal constraints. For example, routine maintenance of the facilities requires temporary shutdown which reduces the total days of potential operation. Historically the combined exports of these facilities is generally 6 to 7 million acre-feet annually, except during dry and critically dry conditions when it is less.

Given the existing level and annual patterns of SWP and CVP water demands, there are periods when "unused" *physical* capacity remains in the system. For instance, if export demands south of the Delta only use 50 percent of the system's existing capacity to export water during a particular month, then "unused" *physical* capacity exists. However, if the existing Project demands use 100 percent of the system's capacity at a particular time, no "unused" capacity exists.

However, this "unused" *physical* capacity is even further limited by regulatory constraints that govern the operation of the various system features. These include, but are not limited to:

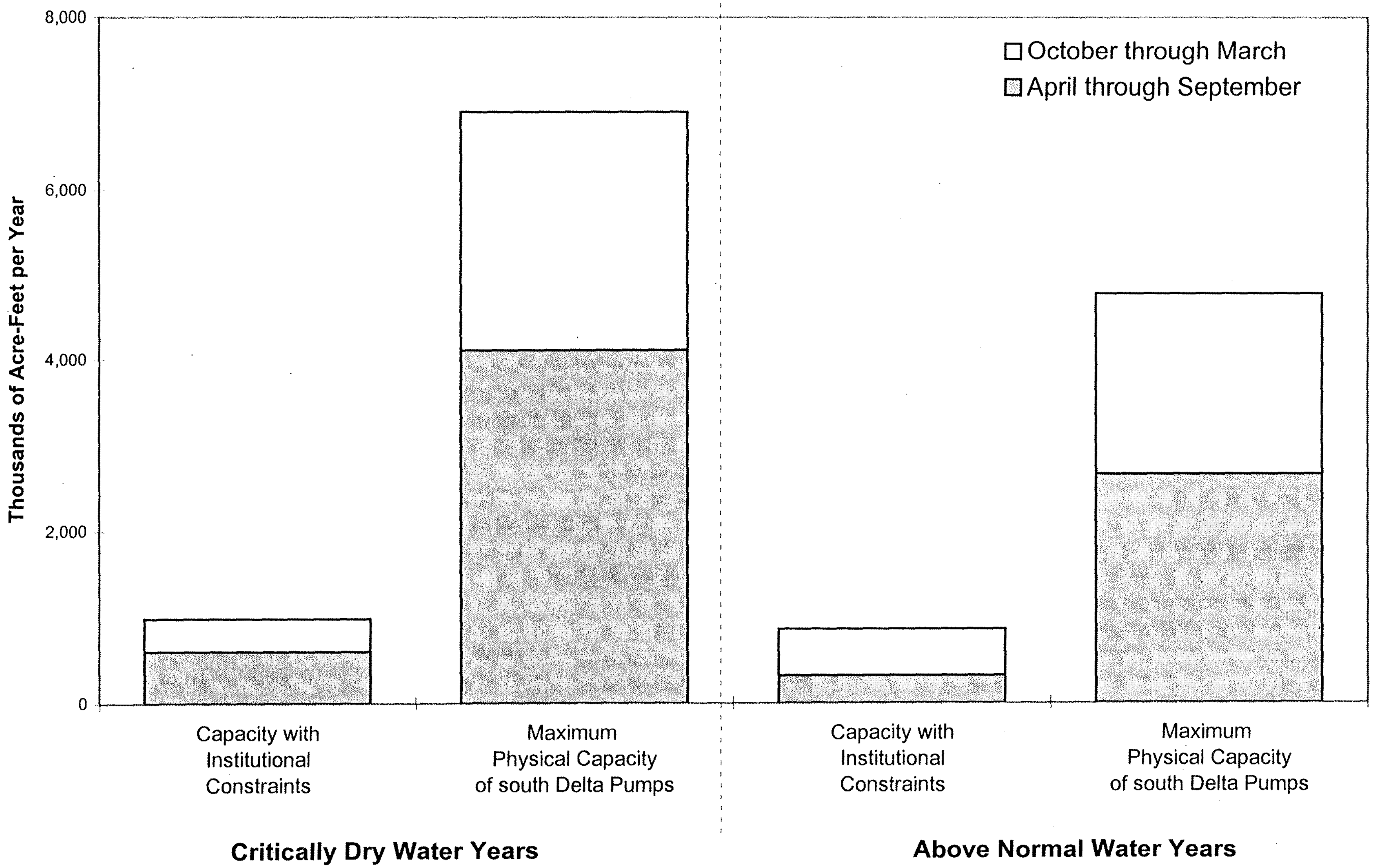
- Delta outflow and water quality requirements and export constraints contained in water rights permits and the Endangered Species Act biological opinions (existing and future)
- the 1994 Delta accord and agreements to operate the CVP and SWP to meet the objectives of the State's 1995 Bay-Delta Water Quality Control Plan
- permit limitations on south Delta pumping (Corps of Engineers)
- the Coordinated Operating Agreement between DWR and the Bureau of Reclamation
- flood control criteria for reservoirs and surface waterways (an operational constraint)

Such regulatory constraints can greatly reduce the "unused" capacity. In some instances, even though physical capacity exists, "unused" capacity due to regulatory constraints may be zero, meaning no additional water can be exported. However, regulatory constraints are not absolute limits on the ability to transport water, especially across the Delta. If a transfer agreement provides sufficient additional water supply to satisfy water quality or outflow requirements (e.g., carriage water), then it may still be transferable (as long as physical capacity exists). Though, in instances where Endangered Species Act biological opinions result in stoppage of pumping, even "unused" capacity will not be available regardless of attempts to provide sufficient additional carriage or transport water.

The results of computerized modeling that assumes use of existing facilities, existing regulatory constraints, and historic hydrologic conditions, allow us to estimate the potential "unused" capacity. As shown in Figure 1, while "unused" *physical* capacity can be as great as 6 million acre-feet during critically dry periods, *regulatory and operational* constraints limit the available capacity in most cases to slightly under 1 million acre-feet. These values, however, are the result of models which assume every acre-foot difference between what is actually pumped and what is theoretically available is "unused". Actual project operations sometimes conservatively assume the facilities are operating at maximum capacity, even when they may not be. For instance, if 6400 cubic feet per second (cfs) of capacity exists but the projects are operating at 6300 cfs, operators assume that there is no additional capacity. The model, however, would count the 100 cfs difference as available for transfers. It would be appropriate to assume that conservative operations of the facilities further reduce the real capacity below the 1 million acre-feet estimated by the models. A more realistic estimate may be that "unused" *regulatory* capacity, or "available" capacity, is between 0.5 and 1 million acre-feet. It should also be noted that this capacity will be directly affected by increases of SWP entitlement deliveries. As project deliveries go up, available capacity for transfers will

Estimated Available Annual Additional Capacity for Water Transfers at Existing South Delta Facilities Assuming Existing Regulatory Constraints

(result of modelling, conservative operating procedures may further reduce this estimate)



correspondingly decrease. As shown on Figure 1, the available capacity in wetter years (above normal) is slightly less than dry years since state and federal project water is more abundant and available for delivery. (For clarity, note that "unused" capacity generally relates to physical constraints while the term "available" capacity refers to conditions constrained by regulations and operations.)

Another physical constraint of the system is the limited additional pumping capacity at the Edmonston pumping plant located at the southern end of the San Joaquin Valley on the California Aqueduct. This facility delivers water to southern California and is estimated to currently have between 0.8 and 1.9 million acre-feet of "unused" capacity annually. This is greater than the regulatory capacity at the south Delta pumping facilities, but it could limit the ability of southern California water suppliers to deliver transfers under existing conditions if Delta export constraints were reduced.

Timing and Demand. The ability to use "available" capacity is dependent on many factors, especially the:

- time the capacity is available (which is dependent on existing physical and institutional constraints)
- demand for transferred water at those times or ability to store surplus water south of the Delta
- willingness to transfer during periods that require significant carriage water requirements (i.e., when regulatory constraints only allow 35 percent of Delta inflow to be exported)
- availability of transferrable water at those times
- economic considerations such as additional pumping cost (on- versus off-peak) and mitigation measures

For instance, though 1 million acre-feet of capacity may exist, much of it may only be available during late fall or early spring, times that may not correspond to any need. If corresponding demand does not exist, or if south of Delta storage is not available, or if transferable water is not present, then the available capacity would not be used. Recently, some of the available capacity in the California Aqueduct (the State's system) has been used to transport water for the federal contractors. It has also been used to a lesser extent to provide "interruptible" supplies to existing State Water Project contractors (interruptible supplies are deliveries of surplus SWP water to contractors above contractual supplies). These deliveries reduce the capacity for non-project related water transfers.

Figure 1 shows the rough distinction between transfer capacity from October through March compared to that from April through September. Depending on the hydrologic conditions of the particular water year, the transfer capacity in particular months can be a significant constraint on the ability to transfer. To date, most short-term transfers have taken place from mid- to late summer through early fall.

Realistically, what may further constrain actual transfers is the export-inflow ratio limitation placed on Delta exports by the May 1995 Water Quality Control Plan. The export-inflow ratio constrains exports from the Delta to only 35 percent of Delta inflows during February through June. From July through January, up to 65 percent of the Delta inflow can be exported. What is significant about this ratio, when it is controlling, is that potential buyers will hesitate to attempt a transfer when they can only export 35 percent of what they purchase. For example, if a buyer wants to export 10,000 acre-feet during April and the export-inflow ratio is controlling Delta export operations, the buyer would have to purchase nearly 30,000 acre-feet. Since 65 percent of the water would be required to flow out the Delta, the actual cost of the 10,000 acre-feet to the buyer would be much greater than the per acre-foot cost paid to the seller ($50 per acre-foot paid for 30,000 acre-feet translates to $150 per acre-foot for the 10,000 acre-feet actually received in the buying region, not including transport or other charges). This added cost would significantly limit the desirability of transfers during such periods, a key reason for its existence, even though capacity to transport the water, and demand for it, may exist. (One purpose of the export/inflow ratio is to focus transfers to periods of time when there would be less impact to fisheries and discourage transfers during critical fishery periods.)

When the export-inflow ratio is not controlling, other State water quality requirements, such as X2, as well as other regulatory constraints are controlling. Water may be easier to transfer when these other conditions are controlling when compared to constraints of the export-inflow ratio.

Another example of the effect of timing on transfers could be a transfer agreement that makes water available through re-operation of an existing reservoir. Re-operation could make the water available only at particular times, depending on the re-operation criteria (e.g., flood pool, power generation, downstream release requirements). If the out-of-basin transferee (buyer) is unable to take delivery of the water at the time it is made available, a transfer will not occur, regardless of available transport capacity. The same could occur with land fallowing programs if the ability to re-regulate the release of water that previously was delivered on a historical agricultural use pattern to a different delivery pattern is constrained by the local operating criteria of the source reservoir.

Also of primary concern to potential transferring parties is reliable access to facilities for long-term transfers. For a long-term transfer to function, the ability to move the water (wheeling) in every year it is needed is crucial. This certainty, however, does not exist under the current system and operating constraints. For instance, if the transfer is scheduled to occur every year in August, but during a particular year, capacity does not exist in August, the transferred water will be "lost". Lack of certain access to facilities has limited the use of long-term transfers. To date, there have been no long-term cross-Delta transfers successfully negotiated, partly as a result of lack of access certainty (no ability to wheel water). Many short term transfers, though, have been successfully completed during the past decade.

Impact of the CALFED Alternatives on Available Transfer Capacity

CALFED has several alternative configurations that include new storage and conveyance options. The effect of these on the ability to physically move water associated with water transfers is still being analyzed at this point in the CALFED process. However, determination of potential water transfer capacity for each CALFED alternative will be included as part of the Programmatic EIR/EIS.

In general, additional storage and conveyance facilities under consideration in the CALFED alternatives could improve opportunities for water transfers by:

- allowing transfer water to be held in new storage facilities until 1) the buying party can accept the water, 2) conveyance capacity exists to transport the water to the buyer, and/or 3) the water may be transported through or around the Delta with reduced restriction;
- allowing transfer water to be moved through or around the Delta during unconstrained periods of time and held in storage south of the Delta until 1) the buying party may accept the water and/or 2) conveyance capacity exists to transport the water;
- retaining water currently spilled by existing reservoirs (surplus to other needs and uses) in new storage facilities, thereby creating additional supplies potentially available for transfer;
- reducing the impacts that water transfers have on the Delta, thereby expanding the periods of time when transfers can occur;
- creating opportunities to move water between new sources and destinations.

Changes to existing regulatory constraints could also result in a variety of effects on the capacity for water transfers, especially changes that result from new species listings under the state and federal Endangered Species Acts. In some instances, the current regulatory constraints create a transfer need by CVP and SWP contractors when their contractual deliveries are reduced. Species recovery could result in a change to the constraints which could reduce the demand for transfers since contractual deliveries could increase. Water transfer opportunities in various areas of the state (not just across the Delta) could ultimately be increased or decreased as a result of changes in:

- regulatory constraints on Delta exports (changes or additions to ESA biological opinions or the Water Quality Control Plan), especially through the listing of new species;
- policies affecting priority of use of storage and conveyance facilities ;
- permitted south Delta pumping capacity (Corps of Engineers operating permit, State Water Resources Control Board water rights permits).
- improved tracking of water for environmental transfers

Use of Models in Determining Transfer Capacity. System operations modeling, linked with detailed Delta simulation modeling, is being used to evaluate the potential water supply impacts and benefits of proposed physical facilities and operational changes associated with Bay-Delta Program alternatives. Through this process, the available physical capacity of primary storage and conveyance facilities -- potentially available to facilitate transfers -- may be evaluated under the assumptions associated with each Program alternative. Through subsequent analysis of model results, the quantity of transfer water that might be moved through the Delta at various times can be estimated, depending on available physical capacities and the regulatory constraints limiting conveyance of water between any two points.

This modeling approach will not provide information on potential local impacts of any specific water transfer. It will also not provide information regarding the "safe yield" for any particular source area. Before implementing any specific transfer, more detailed investigation would be required to evaluate potential groundwater-surface water interaction and potential impacts on third-party water users and the environment.

Modeling Assumptions. A variety of assumptions are required to complete system operations studies. Capacities of existing physical system components such as primary reservoirs, stream channels, and canals, are generally fixed within the simulation model. Proposed facilities may also be represented to evaluate potential benefits and impacts. Regulatory requirement assumptions are also needed but may be varied between model simulations to evaluate cause and effect relationships. These institutional assumptions define: 1) upstream hydrology and water use (depletions); 2) reservoir operations for water storage, flood control, power production, recreational uses, and temperature control; 3) instream flow requirements for fisheries, navigation, and water quality objectives; 4) Delta standards related to instream flow requirements, water quality objectives, X2 requirements, and export limits; and 5) demand patterns for water.

For CALFED modeling studies, physical system components included for simulation range from including only the existing facilities to including 6.7 million acre-feet of new storage along with various Delta conveyance modifications. The institutional assumptions used in the studies generally include existing levels of environmental protection, such as requirements under the SWRCB Bay-Delta Water Quality Control Plan, Endangered Species Act biological opinions, and Central Valley Project Improvement Act. A 73-year historical period (1922 to 1994) is used to provide hydrological input. Levels of demand for water in upstream areas and Delta export service areas are set to simulate both existing conditions and projected 2020-level conditions, as used for all CALFED impact analyses.

Speculative Demand Potential for South of Delta Water Transfers

California already has an active water transfers market. Every year, hundreds of thousands of acre-feet are transferred or exchanged between willing parties. Most of these transfers consist of in-basin exchanges or sale of water among CVP or SWP contractors. In most cases, these exchanges are not under the jurisdiction of the State Water Resources Control Board because there is no change in place or purpose of use (i.e., the water is still used within the CVP or SWP service area). They are also not widely disclosed to the rest of the water supply community because they occur within existing project service areas. (*It should be noted that CALFED's objectives do not include attempting to solve the state's water supply needs. However, transfers may be integral to the state's water supply needs and many transfers may need to move through or around the Delta. For this reason, CALFED is interested in understanding the potential demands for transfers and must address the issues surrounding them.*)

Most of the potential demand for water transfers south of the Delta in the foreseeable future would probably be for urban demands in the Metropolitan Water District of Southern California service area and agricultural demands in the federal San Luis Unit. Other SWP export users, such as Kern County Water Agency, may occasionally import water via transfers for conjunctive use and water banking programs. The amount of water any of these entities may be in the market for, however, is only speculative.

MWD's recent Integrated Resource Plan (March 1996) discusses the potential for transferring up to 400,000 acre-feet of water from the Central Valley. According to the Plan, this amount is only needed once every 4 years (25% of the time). Westlands Water District, as well as other federal San Luis Unit contractors, may be looking to transfer up to 300,000 acre-feet in critically dry years. Because of recent regulatory constraints that have limited full delivery of contracted amounts, this quantity may be desired much more than 25 percent of the time; probably more like 50 percent of the time. DWR's Supplemental Water Purchase Program is also looking for 200,000 acre-feet to help meet SWP contract demands during times of shortage. This may be the same need that is targeted by MWD and other SWP contractors.

Bay Area urban water suppliers could also be buyers in a future water market. The extent to which they may participate in water transfers to augment existing supplies is unknown. However, during the last drought event, several Bay Area suppliers, including the City of San Francisco, Contra Costa Water District and Santa Clara Valley Water District and others, were allocated nearly 100,000 acre-feet from DWR's Drought Water Bank. These quantities may increase as urban population increases and existing supplies become insufficient.

The speculative values discussed above represent independent consumptive use demands and are generally additive. However, since these speculative demands are not needed every year, providing an average annual sum total can be misleading. More discussion of the additive or inclusive nature of these demands is included later in this document.

Sources of Transfer Water. Water to be transferred can come from several sources. If properly managed, three of these sources could yield new water without impacting existing beneficial users. The remaining source requires reallocation from existing uses. Potential sources include:

- reservoir re-operation (yielding new water supplies with no impact to existing users

provided that all instream flow standards are adequate and are met);
- conjunctive use/groundwater banking (yielding new water supplies with no impact to existing users, provided that the program includes a management and recharge program to ensure no adverse impact to local groundwater resources);
- conservation (recovery of water otherwise lost to beneficial uses with no impact to existing users);
- crop shifting/land fallowing (reallocation from one use to another).

The first two sources incorporate changes in the management and operation of existing facilities and aquifers to increase the available yield in the system.

Speculative Demand Potential for Water Transfers to Meet Environmental Needs

Transfers for environmental purposes have also been a regular feature of existing water management for the past 10 years. These have included transfers of water to provide refuge water supplies as well as pulse flows released down the San Joaquin River. In addition to urban and agricultural demand for water transfers, there are also several programs which propose to acquire water through transfers for environmental purposes. Water would primarily be used for instream flow and Delta outflow but could also meet riparian and wetland habitat and wildlife refuge needs. However, ensuring that water actually goes to the intended use will require that it be tracked through the system and properly accounted for in the Delta. For example, water intended to be used exclusively for increased Delta outflow would be subtracted from the actual Delta tributary inflow and outflow calculations. This would administratively remove these flows from availability for export and would allow Delta outflows above the existing standards.

CALFED's Ecosystem Restoration Program Plan (ERPP) and the CVPIA Anadromous Fish Restoration Program (AFRP) will require water to supplement existing instream flows. Current estimates are that implementation of the ERPP targets would require about 400,000 acre-feet and the AFRP, about 600,000 acre-feet. These programs have been developed independently but they target many of the same rivers and tributaries with 80 to 90 percent of the AFRP flows overlapping with ERPP targets, according to CALFED staff. The CVPIA also contains provisions to dedicate 800,000 acre-feet of CVP yield to environmental purposes, as well as another 140,000 acre-feet to meet the incremental Level 4 refuge water supply needs (part of the Central Valley Habitat Joint Venture Plan). Some of the 800,000 acre-feet of dedicated yield may also overlap with AFRP and ERPP flow needs. Specifically, the Bay-Delta Accord provides that any CVP water used to meet the state's water quality control plan or Endangered Species Act requirements is credited against the 800,000 acre-feet. The balance may be used for AFRP or other instream purposes. More discussion about the additive or inclusive nature of these demands is included later in this document.

Sources of Water for Environmental Transfers. Generally, the sources for potential transfer water are the same as indicated previously under south Delta transfer sources.

A promising source could be water conservation actions that do not generate a new water supply, but instead simply transfer "benefits" to adjacent surface waters. It is possible that reducing irrigation losses that return directly back to surface streams and rivers can generate environmental benefits, as long as no adverse impact occurs to existing downstream beneficial users of the return flow. For example, if 20 percent of diverted water that currently returns as surface runoff is not diverted (as a result of efficiency improvements), a quantity of water now available to the previously by-passed stream reach is generated. In addition, the savings could be released from upstream reservoirs on a schedule that benefits fisheries rather than the existing irrigation demand schedule, again as long as existing beneficial users of the return flow are not adversely impacted. To the extent that such actions benefit environmental health without the need to acquire additional water, these flows could be credited toward ERPP and AFRP flow targets.

Additive or Inclusive Nature of Potential Water Transfer Demands

The potential water transfers quantities discussed above are not strictly additive. However, they are not completely inclusive either. Several factors have to be considered when evaluating the additive or inclusive nature of the demands. Examples include:

- Is the transferred water intended to meet the same demand? DWR's proposed Supplemental Water Purchase Program would augment contract supplies during critical water supply periods. A large portion of supplemental water would be supplied to MWD or other SWP contractors in need of drought-year water supplies. It is likely that this would reduce the demand that these agencies would have for transferring water to meet the same drought period need. Therefore, the SWPP demands cannot be directly added to other SWP shortage condition transfer demands such as MWD's anticipated 400,000 acre-feet.

- Is water dedicated for instream flow purposes also required for Delta outflow? If not, depending on the timing, available capacity, and demand, this water could be rediverted once downstream of its areas of need and be transferred to another beneficial user. For example, instream flows on the Yuba River may only be necessary on the Yuba River to its mouth. Once joining the Feather, the water may be available for transfer to another beneficial use. To the extent that recapture of environmental flows can occur, transfer demands for other beneficial uses should not be additive. If flows are dedicated to Delta outflow, one water transfer may serve multiple environmental purposes as it flows downstream to the Bay. In such cases, a unit of water dedicated to AFRP or ERPP flows may help meet several flow targets and yield several benefits, reducing total demands. In other words, one unit of water obtained for AFRP or ERPP targets above existing instream flow standards upstream could also provide water above the Delta water quality and Delta outflow objectives. Alternatively, the water could be accounted for in a way that allows added instream flows upstream and increased exports in the Delta with no increase in Delta outflow.

- Are the AFRP and ERPP targets for tributaries complementary? CALFED Program staff believe that perhaps as much as 80 to 90 percent of the AFRP flows will also function to meet ERPP flow targets. Therefore, ERPP and AFRP flows should not be viewed as mutually exclusive.

- The maximum quantities of transferred water will not be sought annually. In most cases, transfers of water to offset supply shortages will not occur every year, but on a less frequent basis. Smaller quantities may be transferred yearly for direct use or other purposes such as groundwater recharge, groundwater banking, or reservoir refill. Because of the unique hydrologic conditions in the state that result in low precipitation and snowfall in some areas of the state, and greater quantities in other areas, severe shortages will not always occur at the same time throughout the state.

Based on these examples, it is clear that potential demands for agricultural, urban, or environmental transfers should not be directly added. Doing so can inaccurately indicate greater demand for transfers than may actually ever be realized. This is not to imply, however, that all speculative demands are inclusive. Demand for water transfers will likely be great enough that a clear process will be needed to avoid or mitigate third party impacts, groundwater impacts, and environmental impacts where current processes may not adequately do so.

Use of the Economic Models for Transfer Policy Analysis

DWR has developed the Economic Risk Model and has used it as a tool for urban water management planning feasibility studies and EIR/EIS documentation since 1985. The model is demand driven, attempting to solve the unmet demands of a hypothetical need through various supply options based on economics of supply and demand. This model may also be useful to help understand the effect of water transfers on water supply reliability, a CALFED objective, and to help understand the impact of policy-level recommendations to mitigate or avoid third party impacts, though it has not specifically been used for such purposes to date. Specifically, the ERM can be set up to perform the following types of sensitivity analyses:

- changes in regional urban benefits of CALFED storage and conveyance options with respect to changes in the cost and availability of transfers
- change in regional urban benefits of CALFED storage and conveyance options and the quantity of water transferred with respect to changes in third party and environmental impact mitigation policies, including transfer assessments (water surcharges or monetary payments) and restrictions on frequency and cumulative quantities of transfers by a

particular region
- change in demand for transfers and quantities transferred with respect to the CALFED storage and conveyance alternative selected

The ERM uses the concept of least-cost planning to identify the economically optimal mix of statewide and local urban water management options and exposure to the risk of shortage. Attachment 1 provides more detail of the ERM and its methodology.

One important function of the ERM is the ability to estimate the potential for unrestricted transfers that might occur in the absence of limitations to protect from third-party economic impacts. The ERM can estimate the percentage of a region's demand for additional supplies that might be derived through transfers based on the presence or absence of policies designed to provide third party and environmental protection to source water areas. For instance, a south-state water supplier may desire 0.5 million acre-feet of additional supplies during a severe supply shortage. This water could be derived from a number of different contingency options including water conservation, water recycling, local groundwater use, and import of outside sources through water transfers. Given no policy framework for protecting local interests and resources of potential source areas, the majority of the 0.5 million acre-feet demand could be obtained through transfers, since they may be the most cost-effective source. If, however, a policy framework is in place that constrains transfers to avoid or mitigate third party impacts, the percentage of demand met by transfers should be less. The ERM could be use to help the BDAC work group understand the implications of possible policy recommendations by providing generalized results of the level of transfers given different types of transfer constraints. The resulting amount of demand met by transfers would be an indication of the effect of a particular policy.

In addition to the ERM, another economic model is available (the Central Valley Agricultural Production and Transfer Model) to estimate how much water may be made available through activities such as modified cropping and land fallowing. This model is based on agricultural production economics for Central Valley agriculture. It accounts for factors such as water supply, production costs, crop types and acreage, crop value, and price elasticity which is dependent on supply and demand for particular crop types. The results of this model can show the quantities of water made available from particular regions and the associated crop changes that would take place to make water available. This model was used during impact analysis for the CVPIA Programmatic EIR/EIS.

Focus on Resolution of Water Transfer Issues

Important points of this paper are:

- transfer capacity exists now, but it is not particularly reliable and may not be available for non-CVP/SWP purposes;

- new conveyance and storage, if included in a CALFED solution, would increase the capacity and the reliability for transferring water.

The existence of this capacity and the transfer potential it entails raises several issues which were first identified in the draft Water Transfers Discussion Paper (previously distributed to the work group). Two of the most significant issues identified thus far in the CALFED public discussion are:

- the need for measures to avoid or mitigate third-party impacts associated with transfers (whether environmental or economic), and
- the relationship between water transfers and local groundwater resources

The physical and regulatory constraints, whether in their existing form or as a result of CALFED Program actions, will continue to provide some level of protection with respect to the ability to transfer water across the Delta. BDAC and the Water Transfer Work Group must consider whether the existing requirements and processes are sufficient to protect source area economies and resources, or whether additional safeguards should be included in the CALFED Program to ensure such protection.

Attachment 1
Use of Economic Risk Model to Investigate Water Transfers

DWR has used the Economic Risk Model as a M&I water management planning tool for feasibility studies and EIR/EIS documentation since 1985. It is currently being used for CALFED project screening and to develop Bulletin 160-98 regional water management plans.

To focus on the effect of water transfers on the reliability benefits of CALFED options or, conversely, the effect of CALFED options on the reliability benefits of transfers (i.e. the demand for transfers), the ERM can be set up to perform the following types of sensitivity analyses:

1. Change in regional M&I benefits of CALFED storage and conveyance options with respect to changes in the costs and availability of transfers.

2. Change in regional M&I benefits of CALFED storage and conveyance options and the quantity of water transferred with respect to changes in water transfer third-party and environmental impact mitigation policies, including mitigation assessments (water surcharges or monetary payments) and restrictions on frequency of transfers and cumulative quantities transferred by region.

3. Change in demand for transfers and quantities transferred with respect to the CALFED storage and conveyance alternative selected.

The ERM uses the concept of least-cost planning to identify the economically optimal mix of Statewide and local urban water management options and exposure to the risk of shortage.

Figure 1 depicts a theoretical analysis to identify an economically optimal plan for increasing water service reliability. The top portion of each bar shows the expected shortage losses and costs associated with alternative water management plans. Plan number one represents existing conditions (no additional water management actions.) Plans two through fifteen represent increasing effort to diminish losses and costs associated with shortages through the implementation of additional water management options (both long-term and contingency options, including water transfers). However, associated with these plans are increasing water management

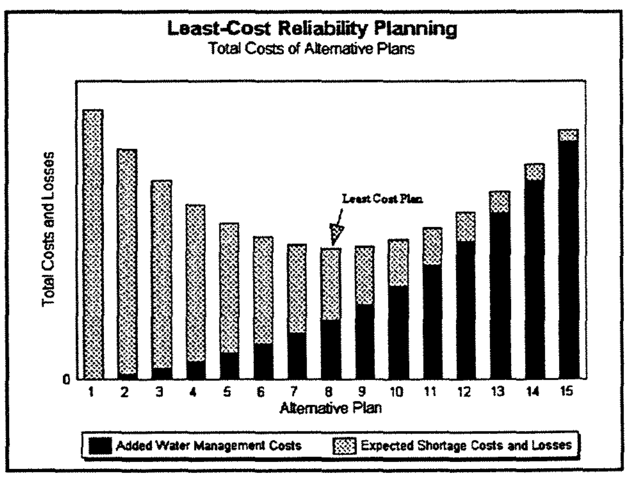


Figure 1 - Identifying an Economically Optimal Plan

expenditures, as illustrated by the lower portion of each bar. The least-cost plan in terms of total costs and losses is plan number eight, where total costs are the lowest. Water management expenditures lower than for plan number eight (plans one through seven) expose the local area to higher shortage-related costs and losses than necessary. Water management expenditures higher than those for plan number eight (plans nine through fifteen) do not "pay for themselves" in terms of additional reductions shortage-related costs and losses.

Figure 2 depicts the primary planning relationships represented in the Economic Risk Model for evaluating, from an economic least-cost perspective, the cost of alternative plans to increase the reliability of a regional water service system. The link between the investment in long-term water management options and the size and frequency of shortages is shown, as is the link between expenditures to make shortage contingency options available as well as the costs and losses associated with those shortages. The ERM uses a yearly time-step hydrologic and shortage impact simulation to best approximate the actual nature of these links. In general, the larger the investment in long-term water management, the less frequent and less severe will be the shortages experienced. Similarly, making shortage contingency options available for future shortage events will lessen the economic, environmental, or social costs of these shortages when they occur.

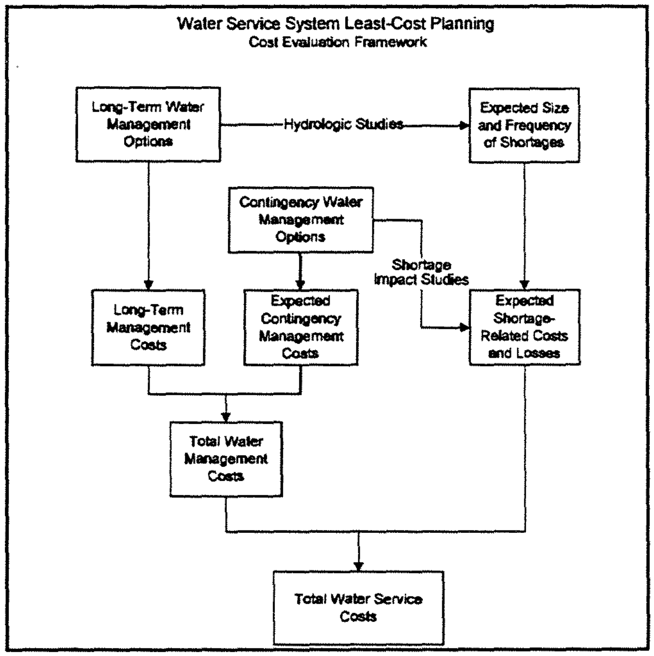


Figure 2: ERM Reliability Modeling Relationships

The capital and operations and maintenance costs of both the long-term and shortage contingency options are included as components of the total water service system costs, the remaining component being the expected costs and losses associated with shortages under those scenarios. Water transfer costs depend upon the quantity transferred during shortages. The price of the transferable water is compared within the simulation to the economic benefit of purchase during each shortage event, thereby affecting the quantity transferred.

Use of different long-term and shortage contingency options affects total water service costs not only directly but also indirectly through their influence on the size and frequency of shortages as well as the costs and losses associated with those shortages. (Because they can also affect costs through their influence on the quality of water provided to users and/or water agency treatment processes, the ERM will be extended to incorporate water quality costs.)

Expected Year 2020 conditions are used to evaluate the potential contribution to regional urban water service reliability of identified water management options for the South Coast and Bay Regions. The option categories capable of being evaluated within the ERM framework from an economic standpoint are:

- Fixed Yield Projects and Programs
  - Water Reclamation
  - Groundwater Recovery
  - Conservation Beyond Urban BMP's
  - Long-Term Water Transfers
  - Ocean Water Desalting
- Variable Yield Projects
  - Central Valley Reservoirs
  - Local Reservoirs
- Contingency Yield Programs
  - Shortage-Related Water Transfers
    - Colorado River Region
    - Central Valley Regions
  - Development of Groundwater Carryover Storage Capacity

The overall conveyance, treatment, and local delivery costs of each option are estimated to the extent possible. When available, data from previously made operations studies are used to measure the yearly contribution of reservoir deliveries to meet both current-year use needs and carryover storage requirements. Shortage-related water transfer options are based on information from pending agreements about total quantities to be made available over the life of the agreement and the yearly quantities that can be made available. In-force agreements on shortage-related water transfers are modeled in the base. Third-party impacts concerns are reflected in assumptions regarding regional restrictions on the frequency of transfers and the total quantity transferred over a specified number of years.

Ideally, because of the hydrologic and operational interdependencies of all the options evaluated, an evaluation of all possible combinations and permutations of the options would be needed to identify a preferred least-cost plan. In lieu of this impractical strategy, the ERM is run for specific reservoir storage supply and Delta conveyance facility scenarios in the context of local water management scenarios which specify three discrete levels of implementation of local water transfer and groundwater carry-over options. The economically optimal use of local fixed-yield options and accompanying exposure to risk of shortage are then identified for each combination of scenarios.

Appendix

Sources of Model Data: DWRSIM output, local hydrologic modeling studies, water management option cost and availability studies done for Bulletins 160-93 and 160-98, shortage management studies re: 1976-77 and 1987-92 droughts, residential customer water price and contingent value surveys. Specific ERM data needs are as follows:

Hydrologic Parameters

- Surface Reservoir Operations
  - Available Carryover Storage Capacity
  - Carryover Storage Supply Curve
- Groundwater Operations
  - Available Carryover Storage Capacity
  - Recharge Capacity (adjusted for efficiency)
  - Extraction Capacity
  - Carryover Storage Supply Curve
- Conveyance Operations
  - Local Aqueduct Capacities
  - State and Federal Aqueduct Capacities

Local Water Management Strategies

- Carryover Storage Programs
  - Use Rules
  - Refill Priorities
- Shortage Management Programs
  - Supply/Storage Status Triggers
    - Contingency Conservation
    - Rationing
  - Expected Effects
    - Overall Use Reduction
    - Use Reduction by User Type

Demand Parameters

- Average Year Demand
  - Current Year Consumptive Use (Includes BMP's)
  - Carryover Storage Use
    - In-Lieu Recharge
    - Direct Recharge

Non-M&I Uses
M&I Supplied Agricultural
M&I Delivery Dependent
Contingency Self-Service Capability
Salinity Barrier
Climate-Related Demand Variation
Current Year Consumptive Use Variance
Regional Precipitation History (100+ years)
Percentage Distribution of Urban Customers by Type
Core (Industrial)
Semi-Core (Commercial and Governmental)
Non-Core (Residential)

Supply Parameters

Imported and Local Surface Supply
Average Year Deliveries (sources without time series data)
Annual Deliveries from Simulation Studies
Contingency Transfer Supply
Conveyance Facility Constraints
Frequency/Quantity Constraints (third-party considerations)
Amount of Carryover Storage Capacity Filled at Start of Simulation

Operations Cost Parameters

Conveyance
Treatment and Delivery
Ground Water Operations
Recharge
Extraction

Shortage Cost and Loss Parameters

Unit Cost of Transferred Water During Shortages
Contingency Program Implementation Costs
Conservation
Rationing
Residential User Loss Function
Unit Non-M&I Loss
M&I Supplied Agricultural Deliveries
Salinity Barrier Use

Supplement B:

Agronomic-Based Rotational Land Fallowing Analysis Report

Supplement B: Agronomic-Based Rotational Land Fallowing - Analysis Report

During the process of refining CALFED alternatives, the Program considered additional actions that might be used to reduce Delta diversions, particularly as part of any variation of Alternative 1. One action considered was the possible use of an agronomic-based, rotational land fallowing program to reduce Delta exports, thereby reducing entrainment impacts on fisheries. Such a program could minimize local socioeconomic impacts when compared to other fallowing or retirement programs. It could also incorporate agronomic practices that could contribute to long-term sustainability for California agriculture. This could in essence result in a new reliable supply of water which could increase the health of agricultural lands and enhance stability in local farming communities.

The conclusion of staff analysis was that this program might best be incorporated into the CALFED Program as part of a water transfers market, with agronomic-based fallowing elements included as an adjunct that could be administered by an agency with soil conservation within its responsibilities.

To better understand the implications of such a program, CALFED has attempted to answer the following questions:

- How would such a program function?
- What are the historic levels of fallowing in San Joaquin Valley export regions?
- What regions would most likely participate?
- How much water could be expected and at what cost?
- What issues might arise from this program?

How Would It Function?

As conceived, an agronomic based, rotational fallowing program would provide an incentive for landowners to temporarily fallow parcels of land that would otherwise be in production. In exchange, water allocated to the parcel of land would remain in the Delta (not be exported) and be used for Delta outflow or other upstream ecosystem benefits. In essence, this program would be a water transfer.

Multiple benefits are expected from this type of program. Not only would the quantity of water diverted at the south Delta CVP and SWP pumping stations be reduced, but the quantity of drainage water generated by export agricultural regions could be reduced (depending on who participates in the program). In addition, the land temporarily fallowed would be 'rested' for one or more seasons to rejuvenate the soil and improve the soil's productive capabilities. Agronomic fallowing may include the planting of particular soil-enhancing crops, such as a legume, that would be tilled back into the soil at a later time to provide additional nutritional benefits. Also, upland habitats created from temporary fallowing could benefit the Central Valley ecosystem.

The program would probably operate during most years, but would focus on enrolling more participants during critically dry years, when fish entrainment in the south Delta pumps has the greatest adverse impacts. The amount of land encouraged to join the program in any one year could depend on the hydrologic conditions of that year as well as the condition of the fisheries and the impact of entrainment relative to other environmental stressors.

Through rotational fallowing, any one parcel of land might only be fallowed for approximately 1 to 3 years, but generally not longer. Land would stay in agricultural production, in contrast to permanent land retirement which removes land from agriculture. By maintaining the land's productivity, agriculture would continue to be viable. This means that jobs would continue to be provided and dollars would be spent in local economies. However, economic and social impacts of any fallowing program are based on models and few historical cases. Whether agronomic-based, rotational fallowing would be better than permanent retirement or other water transfer programs is yet to be tested.

Multiple benefits related to soil conservation could be achieved by promoting appropriate cultural practices on fallowed lands. However, soil conservation in water export service areas is not within the mission of CALFED. This part of the program might need to be administered by another agency working cooperatively with CALFED agencies.

What are the Historic Fallowing Levels?

To estimate the level of participation in an agronomic fallowing program and the level of impacts compared to recent conditions, reviewing historic land fallowing in the Delta export regions of the San Joaquin Valley is helpful. Historic information has been compiled from three sources:

- Westlands Water District data, covering the years 1988-1996.
- Kern County Water Agency data, covering the years 1991-1995 (KCWA apparently did not gather complete data on fallow land prior to 1991).
- General information gathered from the San Joaquin River Exchange Contractors (water districts served by the Delta Mendota Canal [DMC] through an exchange agreement with the Bureau of Reclamation).

For this analysis, fallow land is defined as follows: Land that has an operable water supply and irrigation system, has been farmed within the last 3 to 5 years, and is intended to be farmed within the next 3 years. Land between crops at the time of the survey was excluded, although data may inevitably include some land in this category. Also excluded were abandoned land, land that is "irrigable" but has never been prepared for irrigated agriculture, dryland uses (including grazing), and land used for other purposes on the farm (field roads, buildings, and storage areas).

Three primary reasons for a grower to fallow land are:

1. Agronomic — Fallowing allows the soil to recover its moisture content, structure, and fertility, and can help manage pests. If fallowed land has a cover crop, the cover crop is not fully irrigated, and is usually plowed into the soil to improve organic content and structure.
2. Compliance with the Acreage Reduction Percent (ARP) requirements of USDA commodity programs (often called set-asides) — Prior to the 1995 Farm Bill, a grower had to "set aside" a percent of the qualifying base acreage of a USDA program crop to qualify for deficiency payments and other benefits of farm commodity programs. Cotton, wheat, rice, barley, and corn had ARP requirements. ARPs were determined for each crop for each year based on the relationship between storage (carryover supply) and demand. ARPs ranged from zero to 30 percent. The passage of the 1995 Farm Bill eliminated ARP requirements starting in the 1996 production year. Other provisions in farming legislation that affect growers' decisions to fallow include the Conservation Reserve Program and the 0-50-92 program, though these have seen limited use in Central Valley agriculture.
3. Water shortage — During the late years of the 1987-92 drought, surface water supplies were cut up to 75 percent and in some cases more. Groundwater pumping and land fallowing are the two primary ways that growers respond to drought.

Other reasons for fallowing land include financial constraints, labor or management constraints, and low crop prices or other marketing constraints.

Table 1 summarizes irrigated and fallow land in Westlands Water District from 1988-1996. These data cover a full water delivery year (in 1988 the CVP delivered full contract quantity to Westlands), through the severe drought years of 1991 and 1992, and include the first production year with no ARP requirements (1996). These data indicate the influence and interaction among the factors.

Table 1. Historic Irrigated Acreage and Land Idled, 1988-1996, Westlands Water District

Year	Irrigated Acreage (A)	Land Idled (B)	Total (C)=(A)+(B)	Percent (B)/(C)	CVP Water Delivered (1,000s acre-feet)	Groundwater Pumped (1,000s acre-feet)
1988	522,451	45,632	568,083	8%	1,150	160
1989	503,238	64,579	567,817	11.4%	1,150	175
1990	515,845	52,544	568,389	9.2%	575	300
1991	443,388	125,082	568,470	22%	315	600
1992	457,834	112,718	570,552	19.8%	305	600
1993	476,977	90,413	567,390	15.9%	617	225
1994	487,831	75,732	563,563	13.4%	489	325
1995	520,253	43,528	563,781	7.7%	1,150	150
1996	537,127	26,754	563,881	4.7%	1,092	50

Source: Westlands Water District, Crop Acreage Reports, various issues.

For example, Westlands received full surface water supply in both the 1988 and 1989 water years, yet fallowing increased from 45,000 to 65,000 acres. Some or most of this increase can be explained by the increase in ARP for cotton, the predominant program crop grown in the District. As shown in Table 2, the ARP for cotton was 12.5 percent in 1988, but increased to 25 percent in 1989. Thus, to receive deficiency payments, growers had to set aside (fallow) that percent of their base cotton acreage. In the early 1990's, the "flex" program allowed growers to plant part of their program crop set-aside into another permitted crop, so the set-aside land was no longer necessarily fallow.

Table 2. Set-Aside Percentage for USDA Program Crops in the Central Valley

	1985	1986	1987	1988	1989	1990	1991	1992
Corn	10	17.5	20	20	10	10	7.5	5
Grain	10	17.5	20	20	10	10	7.5	5
Wheat	20	22.5	27.5	27.5	10	10	15	5
Cotton	20	25	25	12.5	25	12.5	5	10
Rice	20	35	35	25	25	22.5	5	0

Source: USDA Agricultural Stabilization and Conservation Service, *Payment Rates for 1978 through the Current Year and Deficiency Payment Rates*, 7-PA Amendment 26, Exhibit 7 (PAR. 18), 1994.

Cotton set-aside had a low year in 1991 with an ARP at 5 percent, yet fallow land was high because of limited water supplies. The first production year without ARPs, 1996, was also a full water supply year. Therefore, as a rough approximation, one might consider the 5 percent fallowing in 1996 to represent fallowing that has occurred for agronomic and market reasons.

Data from Kern County (Table 3) are not as complete, but exhibit a similar trend. Fallowing was high in the most severe drought year, 1991, at about 20 percent of irrigated land. As surface water supply recovered in the mid-90s, fallowing dropped.

Table 3. Irrigated Acreage and Land Idled, 1991-1995, San Joaquin Valley portion of Kern County

Year	Irrigated Acreage (A)	Land Idled (B)	Total (C)=(A)+(B)	Percent (B)/(C)
1991	729,400	180,000	909,400	19.8%
1992	789,600	154,000	943,600	16.3%
1993	800,100	155,000	955,100	16.2%
1994	803,100	144,000	947,100	15.2%
1995	848,400	126,000	974,400	12.9%

Source: Kern County Water Agency, Water Supply Report, various issues.

The San Joaquin River Exchange Contractors provide a different view of historic fallowing patterns. Generally, this region has a firm water supply and is the last of Bureau of Reclamation agricultural export contractors to be shorted. During the severe drought of the late 1980s and early 1990s, growers in this region had a good water supply. Because of the good water supply and other local conditions, this area grows crops other than those supported by the USDA programs. Therefore, fallowing is more a factor of agronomic practices and crop economics. Because of this, fallowing has historically been on the order of 5 percent of the land.

However, growers within the Exchange Contractor's boundaries tend to generally *decrease* their fallowed acres during dry periods. This is in response to *increased* fallowing in other export regions and resulting changes in particular commodity markets. For example, if a large percentage of land is to be fallowed in other export areas, the demand and price for tomatoes may increase. Thus, growers with a good water supply will put additional land into production to take advantage of higher commodity prices. Historically, little land has been fallowed in this area during drought conditions.

What Regions Would Most Likely Participate?

The participants of an agronomic-based, rotational fallowing program are unknown. However, for purposes of this analysis, consideration of one criterion can help us understand who may be willing *or able* to participate.

The most important criterion for participation is the availability of water to transfer. Without a water supply that can be transferred back to the Delta (i.e., not exported in the first place), there is no entrainment reduction benefit, and thus, no reason for CALFED agencies to provide an incentive. If water is available for a particular parcel of land during a particular year, participation in the fallowing program will yield a water supply savings in the Delta.

A rotational fallowing program would likely need the greatest participation during critically dry years, but would still function during most other years. During critically dry years, contracted deliveries of many export water users are reduced. As shown in the previous tables, this reduction can lead to high levels of fallowing (or unsustainable levels of groundwater pumping). In such instances, a grower wanting to participate in a fallowing program may not have the necessary water supply. Their lands would probably be fallowed anyway because of a lack of water. Additional lands in such areas that still have water supplies would not likely be fallowed. Rather, these lands would probably be used to produce a crop.

As noted earlier, some districts along the DMC have ample water supplies. This may result in growers or districts in these area being more interested in participating in a rotational fallowing program. However, higher commodity prices and competition for their water from other water-short export areas may force an increase in the incentives offered by CALFED agencies.

During average years, when reductions in Delta exports are desired, more growers may participate in a fallowing program because more land has adequate water supplies. In addition, because of the complex network of natural and constructed delivery facilities that interconnect agricultural areas in the San Joaquin Valley, non-export regions are able to participate. For example, lands near Fresno irrigated with water from the Kings River could be fallowed. The saved water could be routed to export area lands along the westside of the San Joaquin Valley. These lands would enroll in the fallowing program and leave their water in the Delta. However, the land near Fresno is actually the fallowed land. With the array of hydraulic connections available, many such combinations could provide in-Delta entrainment reduction benefits. As complexity of the transactions increase, though, so will the cost necessary to entice growers to participate.

Generally, export area lands with ample dry year water supplies are the most likely to participate during dry years. During normal years, additional lands will also be able to participate as governed by their water supplies.

How Much Water Could be Expected and at What Cost?

The level of participation in a program such as this is unknown. To get some idea of effects, we can examine a program that prompts agronomic fallowing on five percent of the lands in export regions of the Central Valley. This equates to approximately 100,000 acres of land (approximately 2 million acres of irrigated farmland receive direct exports from the Delta). At 100,000 acres, such a program would affect acreage well below recent levels of idled land.

Each acre of land is assumed to provide about 2.5 acre-feet of water. In some instances, this represents all of the water applied to the land. In other instances, it is only represents the crop use (ET). For 100,000 acres, approximately 250,000 acre-feet of water could be expected to be left in the Delta. The impacts on reducing fish entrainment at the export pumps would depend on actual operations and timing of pumping curtailments.

The cost to purchase water and fallow land will vary based on the water supply, land productivity, crop mix, and competition from other buyers. Based on analysis conducted previously for the Bureau of Reclamation and the CALFED Program, purchasing water in the DMC service area could cost $40 to $50 per acre-foot; in Westlands Water District, $60 to $90 per acre-foot; and in the State Water Project service area, $70 to $100 per acre-foot. Understandably, as competition for water transfers increases, water available in export areas may be strongly sought by water-short export areas. This may increase the incentive necessary to gain participation in the fallowing program.

What Issues Might Arise?

Implementing this type of program would raise several issues and would require gaining the interest and involvement of participants; monitoring the participating lands; tracking the water savings to be left in the Delta and not exported; avoiding groundwater impacts; mitigating other impacts; and maintaining consistency with CALFED Program objectives.

Many agricultural water users may perceive this type of a program as a water transfer program that is burdened with additional requirements. As urban or other agricultural buyers also seek to transfer water, with potentially less cumbersome processes, growers may question the need to participate in a state or federal government program that requires seemingly unnecessary burdens. Unless a strong case can be made for the benefits of agronomic practices that might be a program requirement, overcoming this perception may require an increase in CALFED's incentive.

An issue also arises over methods to account for the water savings and ensure that otherwise idle land is not brought into production. This is a particularly difficult issue given the lack of control over groundwater in these areas. A land fallowing contract would presumably prohibit the grower from irrigating that land with groundwater and may prevent additional pumping on other lands owned by that grower. However, the contract probably cannot prevent other growers in the area from pumping additional groundwater to replace the crop that would have been grown on the now-fallow land. As a result, a fallowing program could induce additional groundwater overdraft with its inherent impacts.

How will participation be monitored to ensure that land enrolled is not growing a crop? Land with no real water supply? Previously enrolled in another type of fallowing program such that the land has not been included in historic water deliveries (over the past 5? 10? years) so has not had a water supply?

Water transfers can have socio-economic impacts on third parties. Information on set-aside programs suggests that significant fallowing has historically occurred with no mitigation for socio-economic impacts. Would mitigation be needed for an agronomic fallowing program that did not exceed historic fallowing levels?

An agronomic-based rotational fallowing program could contribute to the long-term sustainability of San Joaquin Valley agriculture by helping maintain soil productivity. However, this is outside the mission and objectives of the CALFED Program. Could a fallowing program be operated in cooperation with other state or federal agencies with responsibility in this area?

Supplement C:

Determination of Urban Landscape Water Savings from Conservation

Determination of Urban Landscape Water Savings from Conservation

Sacramento

Exist. acres = 100,000
2020 acres = 145,000
ETo (af/ac) = 4.2

Distribution of acres (%)			Analysis of 2020 Conditions compared to 1995					
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	100	100	50	30	44	40	10	31
1.0			25	30	27	30	10	24
0.8			25	40	30	30	75	44
0.6					0		5	2
0.4					0			0

Resultant area (acres)			Analysis of 2020 Conditions compared to 1995					
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	100,000	145,000	50,000	13,500	63,500	40,000	4,500	44,500
1.0	0	0	25,000	13,500	38,500	30,000	4,500	34,500
0.8	0	0	25,000	18,000	43,000	30,000	33,750	63,750
0.6	0	0	0	0	0	0	2,250	2,250
0.4	0	0	0	0	0	0	0	0
sum =	100,000	145,000	100,000	45,000	145,000	100,000	45,000	145,000

Applied Water (acre-feet)

ETo Factor	1995	Base	No Action	CALFED
1.2	504,000	730,800	320,040	224,280
1.0	0	0	161,700	144,900
0.8	0	0	144,480	214,200
0.6	0	0	0	5,670
0.4			0	0
Total water use =	504,000	730,800	626,220	589,050
Incremental Savings		---	104,580	37,170
		Reduction from Base =	14%	5%
Incr. Savings from Reduced ET (<0.8 ETo)		---	0	1,890
		Savings from ET Reduction=	0%	5%
Incr. Savings from Reduced Losses (>0.8 ETo)		---	104,580	35,280

Total % Reduction (Base to CALFED)
19%

Total Amount from ET Reduction
1%

Ratio of Depletion Reduction to Applied Water Savings (from Bull. 160-93 p.155) 0.05 (modified to reflect outdoor water use realities)

Real Water Savings = Reduced ET + (ratio * reduced losses)
Base to No Action = 5,229
No Action to CALFED = 3,654
Total = 8,883

Remaining Applied Water Reduction = total reduction - real water savings
Base to No Action = 99,351
No Action to CALFED = 33,516
Total = 132,867

Determination of Urban Landscape Water Savings from Conservation

Eastside San Joaquin

Exist. acres = 65,000
2020 acres = 120,000
ETo (af/ac) = 4.3

Distribution of acres (%)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	85	85	50	30	41	20	5	13
1.0	10	10	25	30	27	40	5	24
0.8	5	5	25	40	32	40	80	58
0.6					0		10	5
0.4					0			0

Resultant area (acres)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	55,250	102,000	32,500	16,500	49,000	13,000	2,750	15,750
1.0	6,500	12,000	16,250	16,500	32,750	26,000	2,750	28,750
0.8	3,250	6,000	16,250	22,000	38,250	26,000	44,000	70,000
0.6	0	0	0	0	0	0	5,500	5,500
0.4	0	0	0	0	0	0	0	0
sum =	65,000	120,000	65,000	55,000	120,000	65,000	55,000	120,000

Applied Water (acre-feet)

ETo Factor	1995	Base	No Action	CALFED
1.2	285,090	526,320	252,840	81,270
1.0	27,950	51,600	140,825	123,625
0.8	11,180	20,640	131,580	240,800
0.6	0	0	0	14,190
0.4			0	0
Total water use =	324,220	598,560	525,245	459,885
Incremental Savings		---	73,315	65,360
	Reduction from Base =		12%	11%
Incr. Savings from Reduced ET (<0.8 ETo)		---	0	4,730
	Savings from ET Reduction=		0%	7%
Incr. Savings from Reduced Losses (>0.8 ETo)		---	73,315	60,630

Total % Reduction (Base to CALFED)
23%

Total Amount from ET Reduction
3%

Ratio of Depletion Reduction to Applied Water Savings (from Bull. 160-93 p.155) 0.05 (modified to reflect outdoor water use realities)

Real Water Savings = Reduced ET + (ratio * reduced losses)
Base to No Action = 3,666
No Action to CALFED = 7,762
Total = 11,427

Remaining Applied Water Reduction = total reduction - real water savings
Base to No Action = 69,649
No Action to CALFED = 57,599
Total = 127,248

Determination of Urban Landscape Water Savings from Conservation

Tulare

Exist. acres = 70,000
2020 acres = 130,000
ETo (af/ac) = 4.3

Distribution of acres (%)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	15	15	10	10	10	5	0	3
1.0	60	60	60	30	46	50	10	32
0.8	25	25	30	60	44	45	70	57
0.6					0		20	9
0.4					0			0

Resultant area (acres)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	10,500	19,500	7,000	6,000	13,000	3,500	0	3,500
1.0	42,000	78,000	42,000	18,000	60,000	35,000	6,000	41,000
0.8	17,500	32,500	21,000	36,000	57,000	31,500	42,000	73,500
0.6	0	0	0	0	0	0	12,000	12,000
0.4	0	0	0	0	0	0	0	0
sum =	70,000	130,000	70,000	60,000	130,000	70,000	60,000	130,000

Applied Water (acre-feet)

ETo Factor	1995	Base	No Action	CALFED
1.2	54,180	100,620	67,080	18,060
1.0	180,600	335,400	258,000	176,300
0.8	60,200	111,800	196,080	252,840
0.6	0	0	0	30,960
0.4			0	0
Total water use =	294,980	547,820	521,160	478,160
Incremental Savings		---	26,660	43,000
	Reduction from Base =		5%	8%
Incr. Savings from Reduced ET (<0.8 ETo)		---	0	10,320
	Savings from ET Reduction=		0%	24%
Incr. Savings from Reduced Losses (>0.8 ETo)		---	26,660	32,680

Total % Reduction (Base to CALFED)
13%

Total Amount from ET Reduction
15%

Ratio of Depletion Reduction to Applied Water Savings 0.3
(from Bull. 160-93 p.155)

Real Water Savings = Reduced ET + (ratio * reduced losses)
Base to No Action = 7,998
No Action to CALFED = 20,124
Total = 28,122

Remaining Applied Water Reduction = total reduction - real water savings
Base to No Action = 18,662
No Action to CALFED = 22,876
Total = 41,538

Determination of Urban Landscape Water Savings from Conservation

San Francisco

Exist. acres = 155,000
2020 acres = 180,000
ETo (af/ac) = 3.3

Distribution of acres (%)			Analysis of 2020 Conditions compared to 1995					
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	15	15	10	10	10	0	0	0
1.0	60	60	50	30	47	35	20	33
0.8	25	25	40	60	43	55	55	55
0.6					0	10	20	11
0.4					0		5	1

Resultant area (acres)			Analysis of 2020 Conditions compared to 1995					
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	23,250	27,000	15,500	2,500	18,000	0	0	0
1.0	93,000	108,000	77,500	7,500	85,000	54,250	5,000	59,250
0.8	38,750	45,000	62,000	15,000	77,000	85,250	13,750	99,000
0.6	0	0	0	0	0	15,500	5,000	20,500
0.4	0	0	0	0	0	0	1,250	1,250
sum =	155,000	180,000	155,000	25,000	180,000	155,000	25,000	180,000

Applied Water (acre-feet)

ETo Factor	1995	Base	No Action	CALFED
1.2	92,070	106,920	71,280	0
1.0	306,900	356,400	280,500	195,525
0.8	102,300	118,800	203,280	261,360
0.6	0	0	0	40,590
0.4			0	1,650
Total water use =	501,270	582,120	555,060	499,125
Incremental Savings		---	27,060	55,935
		Reduction from Base =	5%	10%
Incr. Savings from Reduced ET (<0.8 ETo)		---	0	15,180
		Savings from ET Reduction=	0%	27%
Incr. Savings from Reduced Losses (>0.8 ETo)		---	27,060	40,755

Total % Reduction (Base to CALFED)
14%

Total Amount from ET Reduction
18%

Ratio of Depletion Reduction to Applied Water Savings (from Bull. 160-93 p.155) 0.9 (modified to reflect outdoor water use realities)

Real Water Savings = Reduced ET + (ratio * reduced losses)
Base to No Action = 24,354
No Action to CALFED = 51,860
Total = 76,214

Remaining Applied Water Reduction = total reduction - real water savings
Base to No Action = 2,706
No Action to CALFED = 4,076
Total = 6,782

Determination of Urban Landscape Water Savings from Conservation

Central Coast

Exist. acres = 35,000
2020 acres = 50,000
ETo (af/ac) = 2.8

Distribution of acres (%)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	5	5	3	0	2	0	0	0
1.0	20	20	15	10	14	5	0	4
0.8	55	55	40	30	37	25	15	22
0.6	20	20	42	55	46	60	65	62
0.4				5	2	10	20	13

Resultant area (acres)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	1,750	2,500	1,050	0	1,050	0	0	0
1.0	7,000	10,000	5,250	1,500	6,750	1,750	0	1,750
0.8	19,250	27,500	14,000	4,500	18,500	8,750	2,250	11,000
0.6	7,000	10,000	14,700	8,250	22,950	21,000	9,750	30,750
0.4	0	0	0	750	750	3,500	3,000	6,500
sum =	35,000	50,000	35,000	15,000	50,000	35,000	15,000	50,000

Applied Water (acre-feet)

ETo Factor	1995	Base	No Action	CALFED
1.2	5,880	8,400	3,528	0
1.0	19,600	28,000	18,900	4,900
0.8	43,120	61,600	41,440	24,640
0.6	11,760	16,800	38,556	51,660
0.4			840	7,280
Total water use =	80,360	114,800	103,264	88,480
Incremental Savings		---	11,536	14,784
		Reduction from Base =	10%	13%
Incr. Savings from Reduced ET (<0.8 ETo)		---	8,092	10,808
		Savings from ET Reduction=	70%	73%
Incr. Savings from Reduced Losses (>0.8 ETo)		---	3,444	3,976

Total % Reduction (Base to CALFED)
23%

Total Amount from ET Reduction
72%

Ratio of Depletion Reduction to Applied Water Savings (from Bull. 160-93 p.155) 1.0

Real Water Savings = Reduced ET + (ratio * reduced losses)
Base to No Action = 11,536
No Action to CALFED = 14,784
Total = 26,320

Remaining Applied Water Reduction = total reduction - real water savings
Base to No Action = 0
No Action to CALFED = 0
Total = 0

Determination of Urban Landscape Water Savings from Conservation

South Coast

Exist. acres = 480,000
2020 acres = 650,000
ETo (af/ac) = 4.0

Distribution of acres (%)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	10	10	5	0	4	0	0	0
1.0	40	40	30	20	27	15	5	12
0.8	40	40	50	60	53	60	55	59
0.6	10	10	13	15	14	20	30	23
0.4			2	5	3	5	10	6

Resultant area (acres)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	48,000	65,000	24,000	0	24,000	0	0	0
1.0	192,000	260,000	144,000	34,000	178,000	72,000	8,500	80,500
0.8	192,000	260,000	240,000	102,000	342,000	288,000	93,500	381,500
0.6	48,000	65,000	62,400	25,500	87,900	96,000	51,000	147,000
0.4	0	0	9,600	8,500	18,100	24,000	17,000	41,000
sum =	480,000	650,000	480,000	170,000	650,000	480,000	170,000	650,000

Applied Water (acre-feet)

ETo Factor	1995	Base	No Action	CALFED
1.2	230,400	312,000	115,200	0
1.0	768,000	1,040,000	712,000	322,000
0.8	614,400	832,000	1,094,400	1,220,800
0.6	115,200	156,000	210,960	352,800
0.4			28,960	65,600
Total water use =	1,728,000	2,340,000	2,161,520	1,961,200
Incremental Savings		---	178,480	200,320
		Reduction from Base =	8%	9%
Incr. Savings from Reduced ET (<0.8 ETo)		---	47,280	83,920
		Savings from ET Reduction=	26%	42%
Incr. Savings from Reduced Losses (>0.8 ETo)		---	131,200	116,400

Total % Reduction (Base to CALFED)
16%

Total Amount from ET Reduction
35%

Ratio of Depletion Reduction to Applied Water Savings 0.8
(from Bull. 160-93 p.155)

Real Water Savings = Reduced ET + (ratio * reduced losses)
Base to No Action = 152,240
No Action to CALFED = 177,040
Total = 329,280

Remaining Applied Water Reduction = total reduction - real water savings
Base to No Action = 26,240
No Action to CALFED = 23,280
Total = 49,520

Determination of Urban Landscape Water Savings from Conservation

Colorado

Exist. acres = 35,000
2020 acres = 75,000
ETo (af/ac) = 6.0

Distribution of acres (%)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	70	70	60	50	55	50	40	45
1.0	30	30	35	40	38	30	30	30
0.8			5	10	8	15	25	20
0.6					0	5	5	5
0.4					0			0

Resultant area (acres)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	24,500	52,500	21,000	20,000	41,000	17,500	16,000	33,500
1.0	10,500	22,500	12,250	16,000	28,250	10,500	12,000	22,500
0.8	0	0	1,750	4,000	5,750	5,250	10,000	15,250
0.6	0	0	0	0	0	1,750	2,000	3,750
0.4	0	0	0	0	0	0	0	0
sum =	35,000	75,000	35,000	40,000	75,000	35,000	40,000	75,000

Applied Water (acre-feet)

ETo Factor	1995	Base	No Action	CALFED
1.2	176,400	378,000	295,200	241,200
1.0	63,000	135,000	169,500	135,000
0.8	0	0	27,600	73,200
0.6	0	0	0	13,500
0.4			0	0
Total water use =	239,400	513,000	492,300	462,900
Incremental Savings		---	20,700	29,400
	Reduction from Base =		4%	6%
Incr. Savings from Reduced ET (<0.8 ETo)		---	0	4,500
	Savings from ET Reduction=		0%	15%
Incr. Savings from Reduced Losses (>0.8 ETo)		---	20,700	24,900

Total % Reduction (Base to CALFED)
10%

Total Amount from ET Reduction
9%

Ratio of Depletion Reduction to Applied Water Savings 0.9
(from Bull. 160-94a p.155)

Real Water Savings = Reduced ET + (ratio * reduced losses)
Base to No Action = 18,630
No Action to CALFED = 26,910
Total = 45,540

Remaining Applied Water Reduction = total reduction - real water savings
Base to No Action = 2,070
No Action to CALFED = 2,490
Total = 4,560